DOCUMENT RESUME

ED 275 556 SE 047 563

AUTHOR Jagoda, Susan Kaschner; Friedland, Mary
TITLE Changing Earth. Earth Science in Action. Teacher's Manual and Workbook.
REPORT NO ISBN-0-88102-024-9
PUB DATE 84
NOTE 55p.
AVAILABLE FROM Janus Book Publishers, Inc., 2501 Industrial Parkway West, Hayward, CA 94545 ($2.85).
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Climate; *Earth Science; Educationally Disadvantaged; Elementary Education; *Elementary School Science; Environmental Education; Geology; Land Use; Physical Environment; Physical Geography; *Science Activities; Science Education; *Science Instruction; Slow Learners; *Special Education
IDENTIFIERS Special Needs Students

ABSTRACT

The Science in Action series is designed to teach practical science concepts to special-needs students. It is intended to develop students' problem-solving skills by teaching them to observe, record, analyze, conclude, and predict. This document contains a student workbook which deals with basic principles of earth science. Seven separate units include: (1) the land around you; (2) the movement of rocks inside the earth; (3) mountains; (4) wearing down mountains; (5) climate; (6) how people change the earth; and (7) the land you live on. The units consist of basic introductory information and questions, worksheets, a self-checking quiz, and instructions for experiments. A cumulative test is provided at the end of the workbook, along with a glossary. The teachers guide (which is included) explains how to use the workbook, together with teaching suggestions and enrichment activities for each unit. (TW)

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Changing Earth

Earth Science in Action

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Changing Earth

Earth Science in Action

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International Standard Book Number 0-88102-024-9

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Printed in the United States of America. 7 8 9 0 0 9 8 7 6 5 4 3

Teacher's Manual

Changing Earth

Susan Kaschner Jagoda

A Janus **Earth Science in Action** Book

Teacher's Manual written by Susan Kaschner Jagoda and Mary Friedland

OVERVIEW

Real-Life Science

Students with special needs often say that science is dull and boring. Yet those students become fascinated when they can see science at work in real life. We wrote ***Changing Earth*** to help students understand Earth science concepts in relationship to the world they know.

Changing Earth, a Janus ***Science in Action*** workbook, was designed for students with learning difficulties. Through a controlled reading level and hands-on activities, *Changing Earth* teaches basic Earth science principles. Students learn about landforms, how scientists think they were formed and will change, and what causes them to change. Students are also encouraged to study the land around them and apply what they learn to their own environment.

Designed for the Reluctant Learner

Changing Earth is written to build the student's confidence as well as skills. Concepts are presented in small, developmental steps. Activities are fun and easy to do. Lessons are reinforced by exercises that check comprehension and require students to apply what they learned.

Changing Earth is part of a set of Janus ***Earth Science in Action*** workbooks. (Other sets are ***Physical Science in Action*** and ***Life Science in Action.***) This book can serve as a core science program or can supplement an existing science curriculum. It can help students meet general and laboratory science graduation requirements.

OBJECTIVES OF THIS WORKBOOK

The Janus *Science in Action* series is designed to teach practical science concepts to special-needs students. It also helps develop students' problem-solving skills by teaching them to observe, record, analyze, conclude, and predict.

The objectives of *Changing Earth* are to help the student:

- gain a basic understanding of how Earth is changing all the time;
- gain a basic understanding about the ways rock moves inside Earth and how those movements change the surface of Earth;
- learn about different landforms (mountains, plateaus, and plains) and how they can change;
- learn some recent scientific theories of how Earth changes, how continents were formed, and what causes changes;
- observe what the land they live on looks like, how it was formed, and how it may look in the future;
- learn a basic vocabulary of words that describe the surface of Earth and how it changes.

READABILITY

The average reading level for *Changing Earth* is below 2.5, according to the revised Spache Readability Formula. Target words, important to understanding the science concepts, are set in boldface type when they first appear in the text, and listed in a glossary at the end of the book. Target words for each unit are listed under "Teaching the Units" in this manual.

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We suggest you review each unit's target words before your students begin that unit. Help students pronounce the words. Encourage them to look up definitions in the glossary. Reinforce students' comprehension with vocabulary exercises and word games.

HOW TO USE THIS WORKBOOK

The Workbook Format

All units in *Changing Earth* are formatted so students can easily recognize what to do on each page.

Units 1 through 6 open with a brief introduction that focuses students on the concepts they'll learn. Students discuss topic questions that preset learning, then do a short vocabulary exercise, "Before You Start," that readies them for the reading that follows. The final lesson in each unit, "Earth Watch," asks students to make observations about Earth's surface in their area.

Units are divided into one- and two-page lessons. Each lesson is followed by an activity or exercise.

Most units end with "Check Yourself," a comprehension exercise, and "Check These Out," a list of activities that expand the concepts just taught. These activities are multi-modal so each of your students can complete at least one of them successfully.

The final unit asks students to compile their "Earth Watch" data and draw conclusions about how the land they live on may change.

Introducing the Book

Bring in news stories and photographs that portray floods, earthquakes, erosion, or other ways Earth is changing. Ask students to relate experiences they have had with such events, and how they think such events affect their lives.

Then pass out the workbooks. Let students leaf through them and comment on the attractive illustrations. Choose a student to read the introduction out loud. Then ask the class to describe the land around their community.

Introducing the Unit

Before you teach a unit, put up posters and pictures that illustrate the concepts taught in that unit. (Many environmental groups provide calendars and posters for a low cost.) Have students describe the land and guess how it got to be that way.

Then direct your students to the picture on the first page of the unit. Again, have them describe the land. Ask a student to read the unit introduction out loud and encourage others to guess answers to the topic questions. Write the answers and post them. When the class has finished the unit, have students compare the answers with what they now know.

Write the "Before You Start" words on the chalkboard (along with any other words you'd like to review). Pronounce the words, have students look them up in the glossary, and discuss their definitions.

Teaching Suggestions

Help Your Students Succeed

We recommend that you keep your class paced together. Review important concepts at the beginning of class, and summarize what students have learned at the end. When questions appear in text, encourage a class discussion.

Walk your students through an exercise the first time it appears. Then gradually allow them to work more independently.

Use the photos in the book to reinforce concepts. With students, discuss the geologic features of the places pictured, then help students find those places on a map.

Bring in books and exhibits that illustrate the lessons. Publications and posters about geological features in our national parks are especially attractive to students. (See "Teaching Aids" for addresses to write to.) Take students on field trips: Visit museums and examine the land in your community.

Be Prepared!

Read each unit before you assign it, and be prepared to discuss the concepts in it. A bibliography at the end of this manual lists some publications that can quickly give you a general knowledge of basic Earth science concepts. Keep reference books in the classroom to help you answer questions students may ask.

Be sure to try out the activities before your class performs them. Several activities require advance preparation, and some ask for special equipment that you may need to locate. You may also need to adapt some of the materials or procedures to meet the special needs of your students.

End-of-the-Book Exercises

Changing Earth ends with "Show What You Learned," a page of two brief comprehension tests. "What's the Answer?" tests students' understanding of major concepts. "What's the Word?" tests their knowledge of critical vocabulary.

About the Glossary

Words that appear in boldface type in the text are defined in a glossary at the end of the book. Words are listed alphabetically and divided into syllables. Definitions are purposely narrow so students can focus on the concepts taught in *Changing Earth*.

TEACHING THE UNITS

Unit 1: The Land Around You

Target Words: *atmosphere, continent, evidence, geologist, landform, mountain, plain, plateau, surface, valley*

This unit describes the surface of Earth and its three main landforms: mountains, plateaus, and plains. Students also learn that Earth scientists base their theories and conclusions on evidence left in Earth's rocks.

PAGE 5: **Top of the World**

Students learn they live on the surface of Earth and that water, land, and atmosphere make up the surface. These parts are always changing. Students are asked to think of a way land and water can change. (Answers might be: Land can be flooded and wash away; water can dry up.)

PAGE 6: **The Shape of the Land**

All lands have basic shapes called landforms. Help students describe the landforms in their area. Students learn about mountains (tallest landform), plains (flattest and lowest landform), and plateaus (not as tall as mountains, not as flat and low as plains).

PAGE 7: **Changing Landforms**

Landforms slowly and constantly change. Students learn how geologists look for evidence that indicates what landforms may have looked like in the past. Volcanoes and earthquake faults offer evidence of how Earth is still changing.

PAGE 8: **Earth Watch**

This first "Earth Watch" focuses on the shape of the land. Students will need a state map that shows prominent features. Inquire at a local automobile association or state highway department for maps.

PAGE 8: **Check Yourself**

1. a. Mountains **b.** Plateaus **d.** Plains
2. a. Mountains can break apart and wear down.
b. Flat lands can become mountains.

Enrichment Activities

- Post a relief map of the United States. Have students bring in postcards, travel brochures, etc. of famous landforms (e.g. Grand Canyon, Mammoth Caves, Great Smoky Mountains). Mark the places on the map and post the pictures around the map.
- Have students look up these national parks and find out about their special landforms: Grand Canyon (Arizona); Yosemite (California); Yellowstone (Wyoming); Isle Royale (Michigan).

Unit 2: Inside Moves

Target Words: *core, crust, fault, fossil, layer, mantle, plates, seismograph*

Students learn about the interior of Earth and the theory of continental drift.

PAGE 10: **Beneath the Surface**

Students learn about Earth's three major layers: a crust, a mantle, and a core. The mantle and core are located inside the Earth and are composed of hot, partly melted rock. The crust is a thin, hard shell covering the inner layers much like an eggshell covers an egg.

1. crust **2.** mantle **3.** core

PAGE 11: **Moving Rock**

When the two sides of a fault move past each other, an earthquake happens. The more the fault moves the more shaking occurs. Using seismographs to record earthquakes, scientists have found earthquakes often happen in long narrow bands that cut across the Earth's surface. Earthquakes can happen anywhere in the world, but recent ones have been in China, Ecuador, Japan.

PAGES 13–14: **Moving Faults**

Materials: *modeling clay or baker's clay made of flour, salt, and water, food coloring or poster paint, table knife*

Students make clay models that help them visualize the ways the sides of faults can move. Use modeling clay such as PLAY-DOH™ or baker's clay that students can help you make.

PAGE 14: **Pieces of Crust**

Long deep cracks (faults) split Earth's crust into huge plates. The movements of the plates caused many changes to happen to Earth's surface and will make similar changes in the future. (This is the *plate tectonics* theory.)

The map shows major faults. Part of California may move up to where Alaska now is located.

PAGE 15: **Moving Continents**

Scientists have found evidence that seems to support the theory that all continents were once joined together into one huge land mass. Faults split the land mass, and the pieces drifted away. (This is the *continental drift* theory.) Greenland probably moved from the equator.

PAGE 16: **Earth Watch**

Students write to the Geological Survey for information on earthquake faults in their state. Check your public library for the address of your state's Survey Office.

PAGE 16: **Check Yourself**

1. crust **2.** mantle **3.** core **4.** crust **5.** mantle, core

Enrichment Activities

- Check with an educational film service for movies about earthquakes and continental drift.
- Have students write stories about what it would be like to be in an earthquake.
- Start an Earthquake Watch map. Mark locations of earthquakes you hear about in the news.

Unit 3: Mountains

Target Words: *collide, erupt, magma, pressure, vent*

Mountains are the tallest and most majestic of Earth's landforms. Students learn how different kinds of mountains are formed.

PAGE 18: **Pushing Up Mountains**

Plates moving towards each other can build up two kinds of mountains—block mountains and folded mountains.

PAGE 19: **Make Two Mountains**

Materials: *baker's or modeling clay, stiff cardboard, poster paints or felt markers (optional)*

Students use clay models to simulate how plates move to form mountains. Explain that this activity is only a simulation, and results may not look exactly like the photos on page 18.

PAGE 20: **Volcanoes**

Hot, melted rock from inside Earth can explode onto the crust to form volcanoes. Volcanic eruptions can build up landforms such as islands (Hawaii), build and tear down mountains (Mount St. Helens), and explode from places where volcanoes had not existed (Paricutin).

PAGE 21: **Inside a Volcano**

A diagram explains what happens when a volcano erupts. **1.** magma **2.** vent **3.** lava

PAGE 22: **Earth Watch**

Students get information about mountains in their area. Have them locate the nearest mountains on a map. If no mountains are nearby, have students find out if there were any mountains in their area in the past.

PAGE 22: **Check Yourself**

1. (Rock on the crust forms two kinds of mountains when) **a.** plates of Earth's crust collide. **2.** (Folded mountains are formed) **c.** when plates collide and push up rock. **3.** (Block mountains are made) **c.** when one plate slides under another. **4.** (Volcanoes are mountains that build up) **b.** when melted rock flows from the crust to the surface.

Enrichment Activities

- Have students build a papier-mache model of a volcano, showing the different layers of lava and ash. Cut a cross-section and label the layers.
- Read stories to students about the eruption of Mount St. Helens.
- Have students find out about instruments geologists use (tiltmeters, seismographs, thermal recorders) to monitor volcanoes and predict eruptions.

Unit 4: Wearing Down Mountains

Target Words: *deposit, dissolve, erode, expand, glacier, igneous rock, metamorphic rock, sediment, sedimentary rock*

Mountains may look almost indestructible but (as students find out in this unit) there are ways that mountains can be worn down.

PAGE 24: **Changing Rocks**

Students learn that igneous, sedimentary, and metamorphic rocks are changed by processes that happen on or below Earth's surface. Students identify the kinds of rocks from photos. (Gneiss is pronounced "NICE"; basalt is pronounced "ba SALT.")

PAGE 25: **Breaking Them Up**

Rocks are not as strong as they first appear. Roots can push into rocks and break them apart. Water in cracks can freeze and expand, pushing them open. Water and acid can also soften and dissolve rock.

PAGE 26: **Rock Breaker**

Materials: *small empty milk carton, stapler, water, tape, freezer*

This activity shows that frozen water expands. Collect milk cartons several days in advance. Wash them out.

To ensure success, make sure students fill the cartons completely and seal them tightly. (You can also use plastic medicine bottles, but do not seal them. The ice will rise above the open mouth.)

What Happens? (wording may vary) **1.** Water expands and takes up more room when it freezes. **2.** When water freezes in a crack, it pushes the crack apart and makes the crack widen. The rock may split apart after several cycles of freezing and thawing.

PAGE 27: **Another Rock Breaker**

Materials: *vinegar, pieces of limestone, small glass jars, felt pens, water*

Students compare two limestones: one soaked in water and one in vinegar. Students learn that vinegar, an acid, dissolves rock.

You can often get limestone from gravel or aggregate companies. Look under *Rock* in the yellow pages of your phone book.

What Happens? (wording may vary) **1.** Nothing happens to the limestone in plain water. **2.** The limestone in the vinegar bubbles and dissolves.

PAGE 28: **Take Them Away**

Rock is broken into tiny pieces called sediments and carried away by moving water. Sediment settles when the water slows down. Deltas, land formed from deposited sediment, is often fertile farmland because of the good soil that accumulates.

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Page 29: **Erosion**

Water, wind, and ice can all cause rocks to erode. Students look at photos that show the results of erosion and identify the cause.

PAGES 30–31: **Make a Stream Table**

Materials: *rectangular plastic or foil pan, scissors or knife, shower hose, waterproof tape, two buckets, sand, water faucet*

Students discover how running water can cause erosion. You can buy most of the materials in a variety or garden store. Choose a large, flat pan such as a kitty litter box or a foil roasting pan. Set up the activity where there is plenty of surface space. The slower the water runs, the more closely the results will resemble erosion.

If you have two adjacent sinks, let the water from the stream table drain into one sink instead of the bucket. (You can let the water drip overnight.) For best results, get a shower hose that runs at a steady, slow trickle. Have students discuss the "landforms" that form.

PAGE 32: **Earth Watch**

Students follow the course of a river in their area. Help them find where the river starts, trace it, and notice landforms along its course.

PAGE 32: **Check Yourself**

(Wording may vary.) **1.** Rocks melt and harden into igneous rock; rocks are pressed and heated into metamorphic rock; rocks break up and reform as sedimentary rock. **2.** Plant roots; weather; and water with chemicals can break up rocks. **3.** Broken-up rock is carried away and deposited.

Enrichment Activities

- Plan a field trip to view a rock and mineral collection at a local museum.
- Start a rock collection. Check the library for reference books to help students identify rocks.
- Have students find out about the Dust Bowl. Then invite a speaker from the county agricultural extension office to explain how farmers control erosion.

Unit 5: Climate

Target Words: *core sample, humid, ice age, moraine*

This unit explains how climate can change the land. Students describe the climate in their area.

PAGE 34: **Cool or Warm, Wet or Dry**

The climate of an area helps determine what the land is like. Students learn about the interaction of climate and landforms. The wet side of the mountain erodes faster.

PAGE 35: **What's Your Climate ?**

Maps show what kinds of climate a place has in *general*. Help your students find their region on the map and determine the kind of climate it has. Be ready for arguments if the map information doesn't quite fit their descriptions. Remember: The map is only a general description of climate. **1.** (San Francisco, California) cool/dry **2.** (Salt Lake City, Utah) cool/dry **3.** (Detroit, Michigan) mild/humid **4.** (Miami, Florida) warm/humid

PAGE 36: **Climates of the Past**

Evidence such as fossils, layers of sediment, and growth rings of trees helps scientists figure out what past climates Earth had. Students interpret the information in a photo of tree rings.

(Wording may vary.) The tree grows fast during the wet years. It grows slowly during the dry years.

PAGE 37: **Ice Ages**

Evidence shows that much of Earth was once covered by thick sheets of ice. Ice sheets changed the landforms they covered. Have students compare this view of Half Dome with the view of it on page 29 (Yosemite Valley). If the glaciers came back, the weather would change; people would move to warmer places; etc.

PAGE 38: **Earth Watch**

Students describe the year-round climate of their area. They find out from older people how that climate may have once been different.

PAGE 38: **Check Yourself**

Accept all appropriate answers, such as:
1. cool/dry, mild/humid, etc. **2.** Plants grow faster and their roots help break down rocks, etc. **3.** Glaciers dug up land, carved huge valleys, hollowed out lakes, etc. **4.** Scientists look at tree rings, etc.

Enrichment Activities

- Have your students write stories about what it would be like if the glaciers came back.
- Invite a meteorologist to talk about the effect of climate on your area.

Unit 6: People Change the Earth

Target Words: *fossil fuels, greenhouse effect*

People make changes in the land. Those changes happen more quickly than natural changes, and are often hard to change back. Students learn what people are doing about their changes.

PAGE 40: **Builders and Makers**

The advance of civilization has resulted in vast changes to Earth. Students read about some of those changes and think of others on their own.

PAGE 41: **The Greenhouse Effect**

The greenhouse effect is the way the atmosphere holds in heat energy from the sun. Many scientists

think that burning fuel is changing the atmosphere. Students say what might happen if Earth gets warmer (more plants will grow, ice will melt, etc.); colder (more glaciers would form, winters would last longer, etc.); and if Earth didn't have an atmosphere (it would burn up during the day and freeze at night).

PAGE 42: **Looking at the Future**

People now try to predict future effects before making changes to Earth. Students read how geologic information is used to plan communities. Ask students what information they would want before building a house.

PAGE 43: **Earth Watch**

Students examine a local construction project and tell what changes are being made to the land.

PAGE 43: **Check Yourself**

(Answers may vary.) **1.** People fill in rivers; blow up landforms; dig deep mines; etc. **2.** People burn fossil fuels that pollute the atmosphere. **3.** We can study the land; try not to ruin it; etc.

Enrichment Activities

- Ask someone from a civil engineering firm to explain environmental impact studies.
- Have someone from a local planning department talk to your class about land development plans.

Unit 7: The Land You Live On

Students apply what they learned by summarizing the features of land in their area.

PAGES 44–45: **The Land You Live On**

Students compile data from their "Earth Watch" activities, and predict what their area will be like in one million years.

Enrichment Activities

- Have students ask community residents how their area has changed since people settled there.
- Take your class to a science fiction movie about what Earth might be like in the future (e.g. *Soylent Green*).

Show What You Learned

PAGE 46: **What's the Answer?**

1. a. plains, plateaus, mountains. **2. a.** cracked by faults; **c.** moving. **3. b.** plates collide; **c.** volcanoes erupt. **4. a.** plants; **b.** acids; **c.** wind and running water. **5. a.** glaciers; **b.** heavy rain. **Why should we be worried about how people change Earth?** Accept all appropriate answers.

PAGE 46: **What's the Word?**

1. Continent **2.** Magma **3.** Erode
4. Landform **5.** Glacier **6.** Sediment
7. Geologist

TEACHING AIDS

Resources

Check with the geology or Earth science department of a nearby college for more information and materials about the topics covered in this book. A volunteer graduate student might be willing to take your students on a field trip to a local geologic site. Local state or national parks often have naturalists available to lead tours through areas of geologic interest.

The following organizations offer materials such as brochures, maps, posters, films, and slide sets:

- Agency for Instructional Television, Box A, Bloomington, IN 47401
- American Geological Institute, 2201 M St., Washington, DC 20037
- Lawrence Hall of Science, University of California, Berkeley, CA 94720
- National Association of Geology Teachers, 1041 New Hampshire St., Lawrence KS 66044
- National Earth Science Teachers Association, Department of Science, Lansing Community College, 419 N. Capital Ave., Lansing, MI 48901
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Boulder, CO 80302
- U.S. Geological Survey, Branch of Distribution, 1200 South Eads St., Arlington, VA 22202

Bibliography

Alaska Woman, by Genevieve Gray. EMC Corp., 1977.

The Day the Earth Shook, by Jacqueline Cervon. Coward, McCann, and Geoghegan, Inc., 1969.

"Earthquakes: Predictable Disaster?" by David M. Stewart. In *The Science Teacher*, October, 1977, pp. 34–43.

Earthquakes: A Primer, by Bruce A. Bolt. Freeman, 1978.

"Fire and Ice: The Cascade Volcanoes," by Stephen Harris. In *The Mountaineers*. Pacific Search Press, 1976.

Global Jigsaw Puzzle: The Story of Continental Drift, by Irene Keifer. Atheneum Publishers, 1978.

Investigating the Earth, by the American Geological Institute. Houghton Mifflin Co., 1973.

"ISTA Spectrum." University of Illinois, Spring, 1983.

Landforms and Landscapes, by Sherwood D. Tuttle. Wm. Brown Co., 1970.

A Sense of the Earth, by David Leveson. Doubleday, 1972.

Shakes, Quakes, and Shifts: Earth Tectonics, by Franklyn M. Branely. Corwell, 1974.

The World Book Encyclopedia. World Book—Childcraft International, Inc. 1978.

Introduction

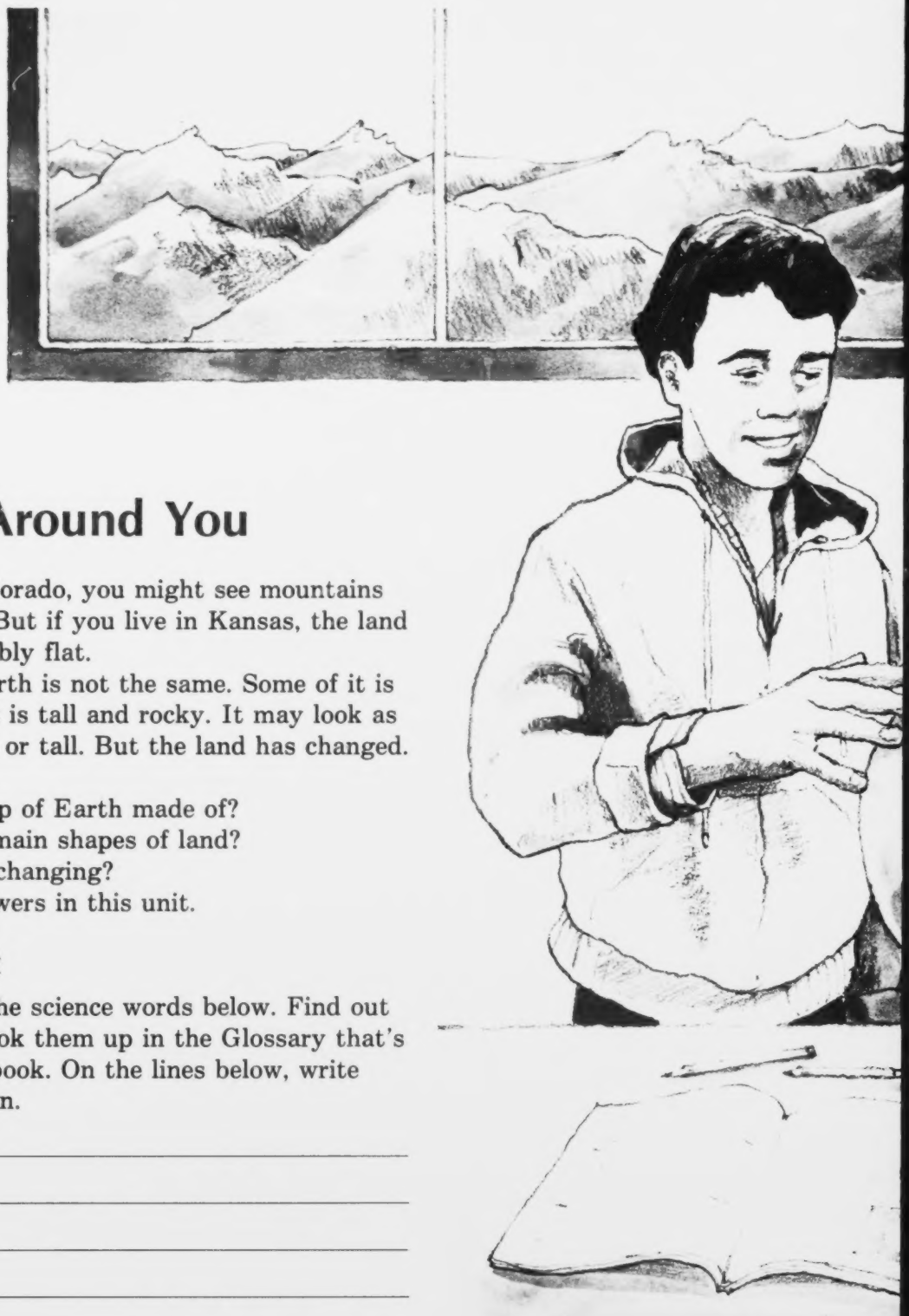
Do you remember hearing news stories like these: *Volcano Blows in Hawaii! Snowstorms Bury the Northeast! Earthquake Shakes California!*

Those happenings are news because they can change people's lives. But they also do this: They can change the surface of Earth.

Ever since Earth began, it has been changing. And it is changing still. Some changes happen suddenly, such as when a volcano blows. But most changes happen very slowly.

In this book, you'll learn how Earth changes. You'll find out what makes those changes. You'll also find out how the land *you* live on now is changing.

When you finish this book, you'll know about the main kinds of land on Earth. You'll understand how they came to be the way they are. And you'll learn what scientists think will happen to Earth in the years to come.



Unit 1

The Land Around You

If you live in Colorado, you might see mountains from your window. But if you live in Kansas, the land around you is probably flat.

Land all over Earth is not the same. Some of it is very flat. Some of it is tall and rocky. It may look as if it always was flat or tall. But the land has changed. It is changing still.

- What is the top of Earth made of?
- What are the main shapes of land?
- How is Earth changing?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary that's at the back of this book. On the lines below, write what the words mean.

1. **continent** _____

_____

2. **evidence** _____

_____

3. **surface** _____

_____

Top of the World

You live on the *surface* of Earth. The surface is made up of three parts. One part is solid, one part is liquid, and the other part is made up of gas. You live on the solid part.

What is the solid part called?

_____

Right! It's called *land*. Land covers all of Earth. We live on pieces of land called *islands* or *continents*.

Look at a map or a globe of the world. It shows some of Earth's land. It also shows the liquid part of Earth's surface. What is that part?

_____

Right! *Water* is the liquid part of Earth's surface. Water covers nearly three-fourths of Earth. Most of that water is in our oceans.

The last part of Earth's surface is made up of gas. It covers the whole Earth, both the land and the water. What is that part of Earth's surface?

_____

Did you say *air*? Air is also called the **atmosphere**.

Land, water, and atmosphere are all part of Earth's surface. Each of those three parts is always changing and moving. For instance, you know that the atmosphere changes. One day it can be sunny and clear. The next day it can rain.

How do you think land can change?

_____

_____

How do you think water can change?

_____

_____

U.S. Geological Survey

The Rocky Mountains are in the middle of the United States.

Landform: _____

G. K. Gilbert, U.S. Geological Survey

The Great Plains are in the Midwest.

Landform: _____

The Shape of the Land

Look at the land around you. What does the land look like? Is it hilly? Is it flat? Are there any **mountains** nearby?

_____

_____

What you see is the *shape* of the land. Land can have different shapes. Those shapes are called **landforms**. A hill is an example of a landform. So is a **valley**.

Scientists who study land are called **geologists**. They say there are three main kinds of *landforms*. Those landforms are mountains, **plains**, and **plateaus**.

Mountains are tall landforms. Mountains rise up from the surface. They are often very steep.

Plains are low, flat landforms. They can cover many miles. They are found in the middle of continents. They are also found next to oceans.

Plateaus are landforms that are not as tall as mountains. They are also not as flat and low as plains. They can be hilly. They can have valleys.

The photographs above show the three main kinds of landforms.

Look at the pictures carefully. Then write the name of the landforms under each picture.

Ross Hall

The Columbia Plateau is in the State of Washington.

Landform: _____

Changing Landforms

Mountains look as if they will stay the same forever. But mountains can change. They can break apart. They can wear down. As the mountains wear down, they can change into plateaus.

Those plateaus can also change. They can wear down and change into a landform that is low and flat. What landform is that?

_____

Right! That landform is a plain.

Did you know that plains can also change? They can change into mountains! Geologists think that the Rocky Mountains once were as flat as the Great Plains of the Midwest.

It takes millions of years for one landform to change into another. Geologists study the changes. They look for *evidence* — clues — to prove that landforms have changed.

For instance, geologists sometimes find seashells in rocks that are at the top of mountains. What do you think that tells them about the mountains? (Hint: Where do you usually find seashells?)

_____

_____

Right! The mountains were at a seashore. They were probably low and flat then.

Geologists also find evidence that Earth is still changing. What do you think some evidence might be?

_____

_____

Earth Watch

1. Where do you live?

   City or town: _____ State: _____

2. Which kind of landform do you live on?

   _____

   What does it look like?

   _____

   _____

   _____

Check Yourself

Put an **X** by the right answers. (The first is done.)

1. Which three are landforms?

   _X_ a. Mountains

   _____ b. Plateaus

   _____ c. Oceans

   _____ d. Plains

   _____ e. Air

2. What two ways can landforms change?

   _____ a. Mountains can break apart and wear down.

   _____ b. Flat lands can become mountains.

   _____ c. The atmosphere changes into mountains.

Check These Out

1. Get a globe that shows you the landforms of Earth. (It will show you how high and low those landforms are.) Turn the globe so that you are looking at Antarctica (the South Pole). Is there more land or more water on that side of the world? Find all the continents.
2. Scientists think Earth is about 4½ billion years old. They call this amount of time *geologic time*. Find out more about geologic time. When did life begin on Earth? What are the time periods?
3. Find out what the following landforms look like. Where are they found?
   - Beaches
   - Islands
   - Caves
   - Mesas
   - Drumlins
   - Valleys
   - Canyons

Unit 2

Inside Moves

Suppose you work in a store. You come in one morning and see this: Shelves tipped over. Boxes and broken bottles on the floor. Cracks in the wall. What happened was an earthquake!

You probably felt that earthquake. An earthquake is one example of how Earth can move. Geologists think that the continents weren't always where they are today. They think the continents must have moved from somewhere else!

- What is Earth like beneath the surface?
- What causes Earth to move?
- What causes earthquakes?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **fault** _____

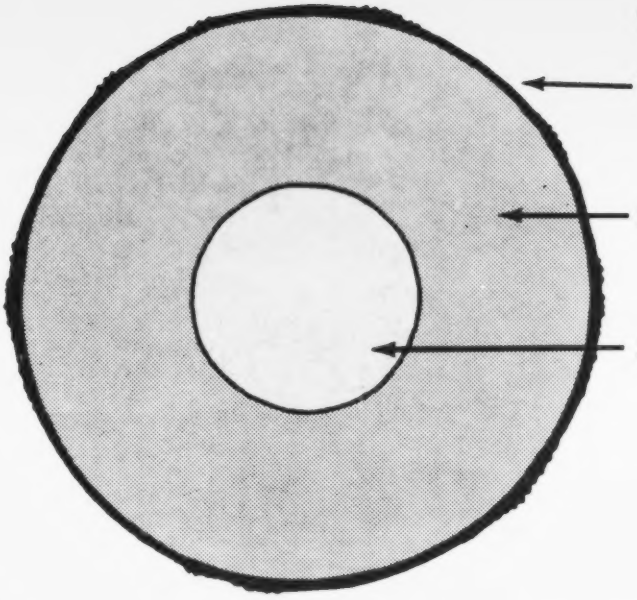
_____

2. **fossil** _____

_____

3. **layer** _____

_____



The main layers of Earth

1. This is the ___ ___ ___ ___ ___ .
   It is the top layer of Earth.
   It is made up of solid rock.

2. This is the ___ ___ ___ ___ ___ ___ ,
   or middle layer of Earth. It is
   made up of very hot rock.

3. This is the ___ ___ ___ ___ ,
   or center of Earth. It is made up
   of very hot and heavy rocks and minerals.

Beneath the Surface

Suppose you could dig a hole to the center of Earth. What do you think you would find?

_____

_____

You would find different *layers* of rocks.

No one has ever been able to dig to the center of Earth. (In fact, no one has been able to dig through the top layer of Earth.) But geologists think they know what the different layers of rocks are like. The diagram on this page shows the main layers.

The top layer is called the **crust**. It is made up of solid rock. It is the thinnest layer of Earth.

The middle layer is called the **mantle**. Geologists say that the mantle is made up of very hot rock. Some of the mantle is partly melted.

The last layer makes up the very center of Earth. Geologists think that layer is made up of very heavy rocks and minerals. They also think it is very hot. What do you suppose that layer is called? (Hint: Think of the center of an apple.)

_____

Right! The center of Earth is called the **core**.

Now look at the diagram again. Write the name of each layer on the diagram.

W.C. Mendenhall, U.S. Geological Survey

In 1906, San Francisco was almost destroyed by an earthquake.

R.E. Wallace, U.S. Geological Survey

The San Andreas Fault caused the San Francisco Earthquake.

Moving Rock

Have you ever been in an earthquake? If you have, what was it like?

The ground probably shook hard. Chairs and lamps jumped around. Maybe even parts of buildings fell down. All that happened because the Earth's crust *moved*. It shook everything on top of it.

Sometimes the crust moves a lot. That's what happened in 1906 when a terrible earthquake shook San Francisco.

Geologists believe that the San Francisco earthquake was caused by a *fault* near the city. A fault is a long deep crack in the Earth's crust.

How does a fault move? Put your hands together so your palms touch. Each of your hands is like the side of a fault. Now slowly move your hands past each other. The sides of a fault can move past each other like that. When that happens, the crust shakes — and there's an earthquake.

Earthquakes happen somewhere on Earth every day. Many of them are so small we don't feel them. But geologists know they happen because they use **seismographs** — machines that can record even the smallest earthquakes.

Seismographs show that many earthquakes happen in the western United States. Where else in the world do they happen?

Moving Faults

You can see the ways faults move by making this clay model. You'll need four pieces of clay, each a different color.

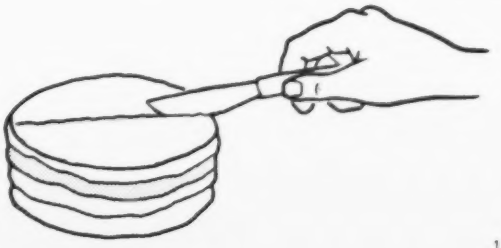
You can use the modeling clay that toy stores sell. Or you can make baker's clay: Mix 2 cups of flour with 1 cup of salt. Add about 1 cup of water to make a stiff clay. Knead the clay until you can stretch it.

Divide the clay into four pieces. Color three of the pieces a different color: Put a few drops of food coloring or poster paint in each piece. Knead the clay until the color is mixed in.

1

With your hands flatten the four pieces of clay. Put them on top of each other to make a stack of different-colored layers. The layers are like layers of different kinds of rocks in Earth's crust.

Make a line across the top of the clay. That line is like a road on Earth's crust.



1

2

Cut across the line. Then cut the stack in half. You now have a crack in the clay. What is that crack like?

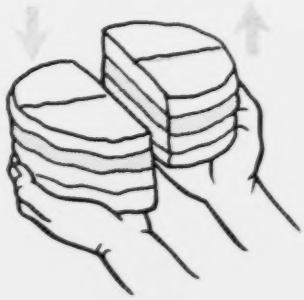
Right! The crack is like a fault in the crust.

2

3

Pick up the two halves of clay. Move one half up. Keep the other half down. That's one way a fault can move. What happens to the layers in each half?

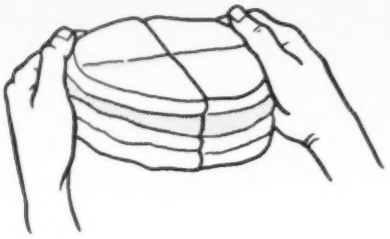
Yes: The layers in one half don't match the layers in the other. Geologists tell how a fault has moved by looking at layers of rocks in the two sides of a fault. They see if the layers match.



3

4

Now, place the two halves of clay on your table. Put them together again. Make sure the lines in the two halves match.



4

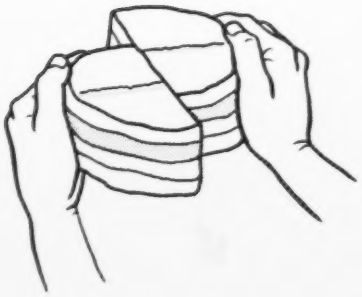
5

Move the two halves past each other. That's another way a fault moves. What happens to the "road" on top of the clay?

_____

Right! It breaks into two lines.

Geologists look for things that should be in a straight line, such as roads. If roads or layers of rocks are in two parts, they know that a fault has moved.



5

6

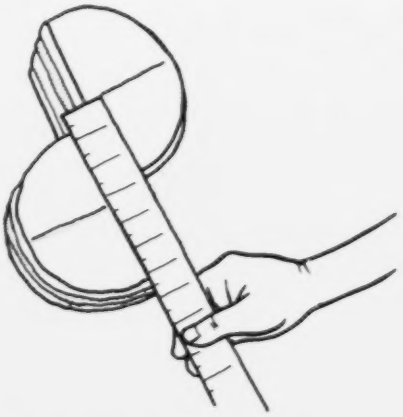
Geologists can also measure how much the fault has moved. How can they do that?

_____

They measure the distance between the two parts.

Get a ruler. Put it on the crack at the top of the clay. Measure the distance between the two lines. How far did your fault move?

_____



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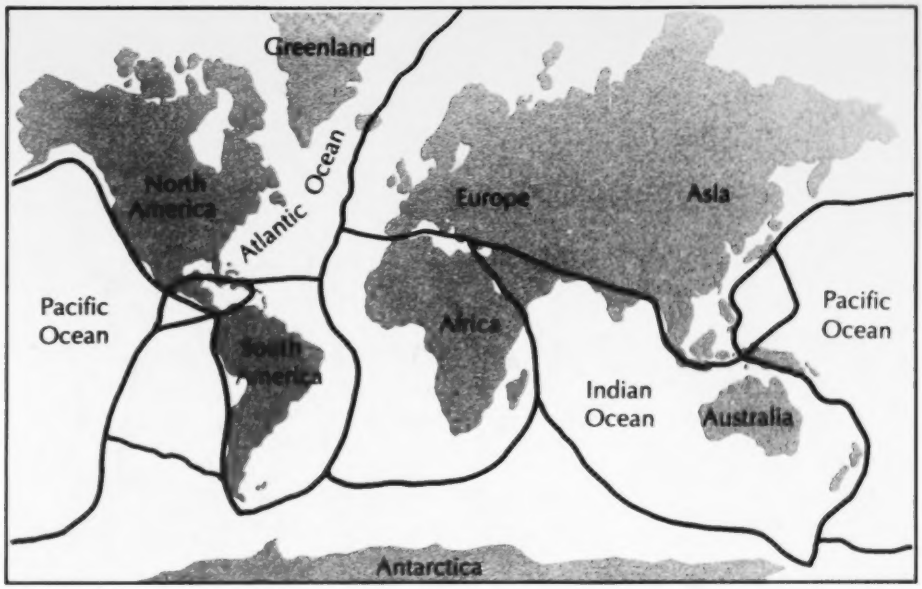


Earth today has many continents.

Pieces of Crust

You learned that a fault is a long, deep crack. The crust all over Earth is cracked by faults. The map on this page shows Earth's main faults. Notice this: They break up Earth's crust into huge pieces.

Geologists call those pieces **plates**. They say that the plates are really huge blocks of solid rock. On the map, find the plate that your country is on. What continent is on the plate?

_____

What ocean is on the plate?

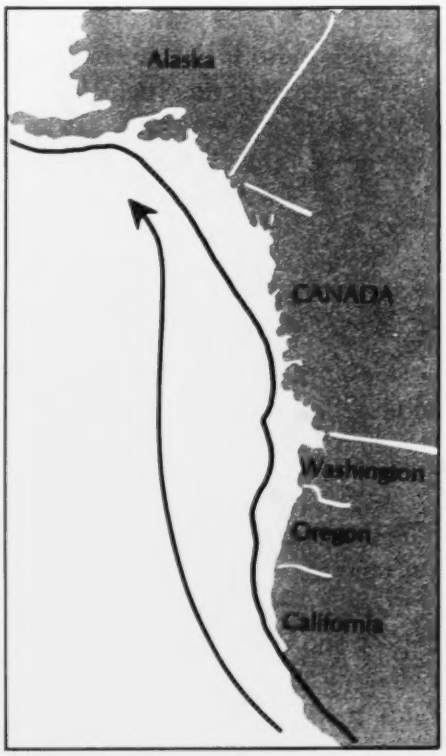
_____

Geologists think that the plates ride on Earth's middle layer, the mantle. (Remember: Some of the mantle is made up of partly melted rock.) They believe the plates are always moving.

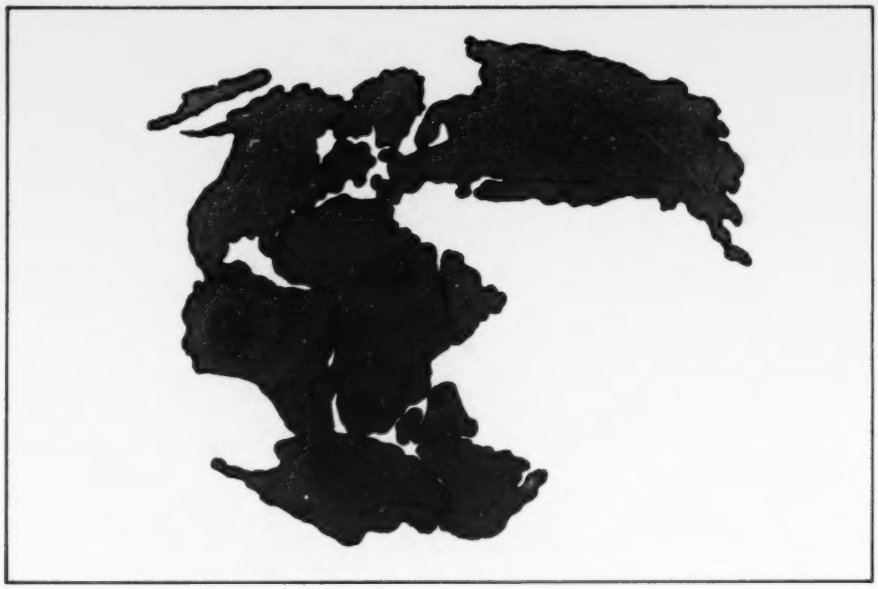
Of course, the plates move very slowly. But they can move as much as two inches (about five centimeters) a year. That may not seem like much, but in a million years those inches will add up!

When a plate moves, the land on top of it moves too. For example, geologists say that part of California is slowly moving north. Where do you think that part will be a million years from now?

_____



Where is part of California moving to?



Geologists believe that Earth once had only one huge continent.

Moving Continents

What do you think Earth looked like 200 million years ago? The map on this page shows what many geologists think. They think Earth had only one huge continent, surrounded by one huge ocean.

Look at the map on the other page. It shows Earth today. Earth now has seven continents. What do you think happened?

_____

_____

The huge continent was probably split by faults. They split the continent into seven pieces that slowly moved away.

Geologists think that's what happened because of certain evidence. Here's one evidence: Look again at the map of Earth today. Look at the shapes of the continents. Geologists say those shapes are like the pieces of a jigsaw puzzle. The shapes look as if they could all fit together to form one huge piece.

Here's more evidence: All the continents have certain kinds of rocks. And sometimes they have fossils of plants and animals that lived at the same time. Those rocks and fossils show geologists that the continents were once the same land.

Fossils also show geologists where a land might have moved from. For example, Greenland is close to the North Pole. It is very cold. But scientists have found fossils on Greenland that show it once was very warm. Where do you think Greenland moved from?

_____

Earth Watch

Find out when your state had earthquakes. Find out where the faults are. Your state government has that information. Write to *The Geological Survey Office* at your state capital. Ask these questions:

1. Have there been earthquakes in our state? Where? When?

_____

2. Are there any faults in our state? Where is one located?

_____

Get a map of your state. Mark the places where earthquakes happened. Mark the places where faults are.

Check Yourself

Which layer of Earth are these sentences about? Write *crust*, *mantle*, or *core* below each sentence.

1. This layer is cracked by faults.

_____

2. Plates ride on top of this layer.

_____

3. This is the center of Earth.

_____

4. During an earthquake, this layer moves.

_____

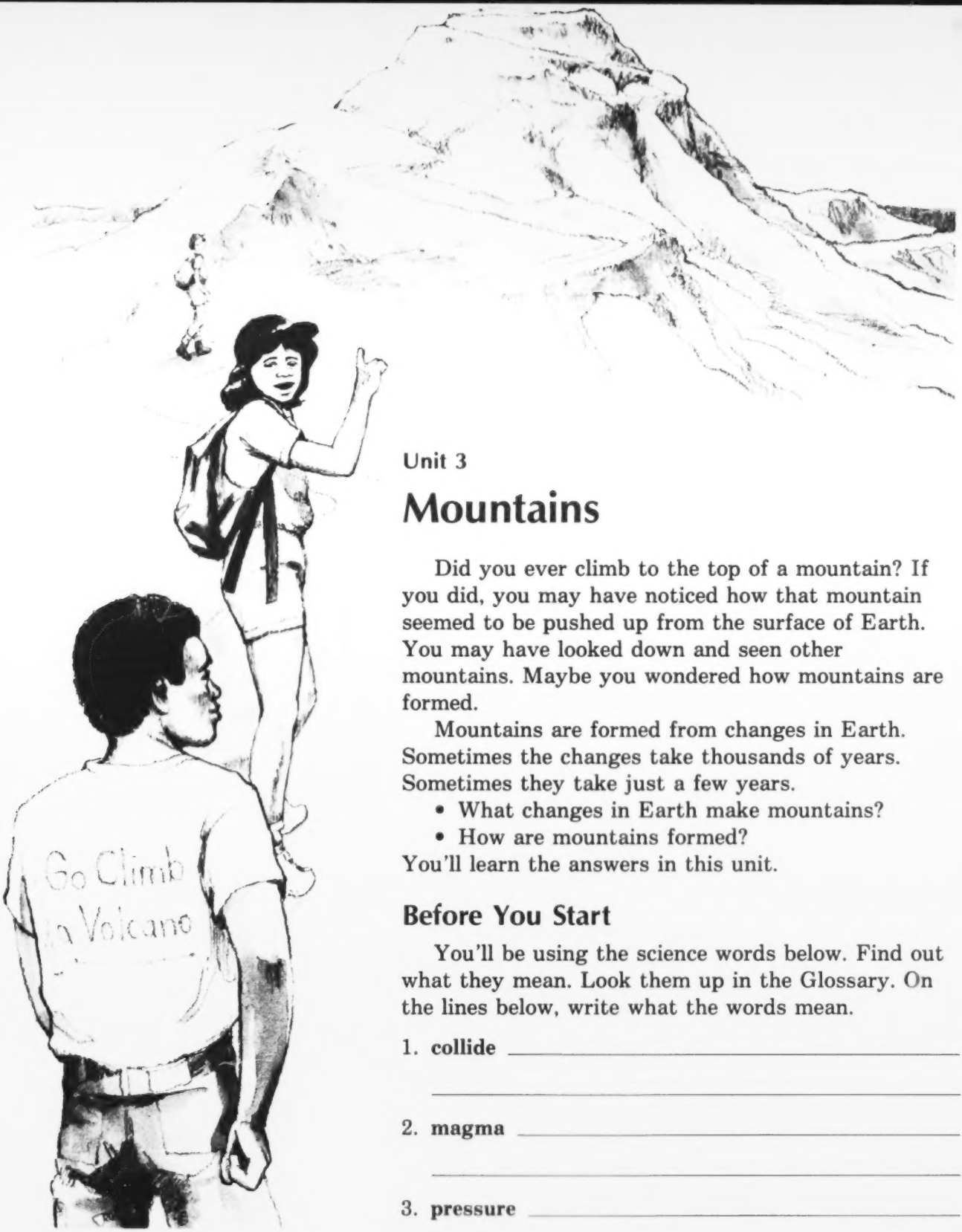
5. These two layers are hot rock.

_____

_____

Check These Out

1. Watch newspapers for stories about earthquakes. Find out where the earthquakes happened. Mark where some happened on a map of the world. How big were the earthquakes? Keep a notebook of your articles.
2. Find out more about the earthquakes that happened in these cities. Which earthquake caused the most damage?
   - San Francisco, California, 1906
   - Coalinga, California, 1983
   - Anchorage, Alaska, 1964
   - Lisbon, Portugal, 1755
   - New Madrid, Missouri, 1811-12
3. Put tracing paper on a large wall map. Trace the outlines of Africa, North America, and South America. Cut them out. Now try to put them together like the pieces of a jigsaw puzzle. How well do they fit?
4. Project Mohole was a plan to drill a hole through Earth's crust. Find out if scientists were able to finish it.



Unit 3

Mountains

Did you ever climb to the top of a mountain? If you did, you may have noticed how that mountain seemed to be pushed up from the surface of Earth. You may have looked down and seen other mountains. Maybe you wondered how mountains are formed.

Mountains are formed from changes in Earth. Sometimes the changes take thousands of years. Sometimes they take just a few years.

- What changes in Earth make mountains?
- How are mountains formed?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **collide** _____

_____

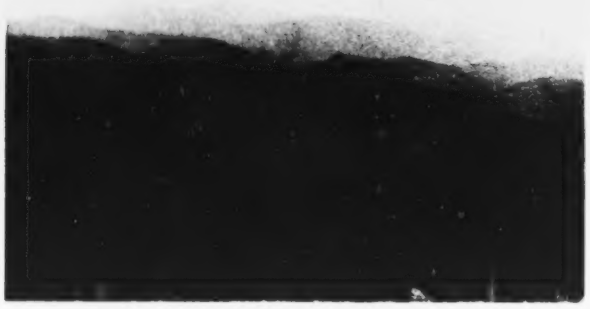
2. **magma** _____

_____

3. **pressure** _____

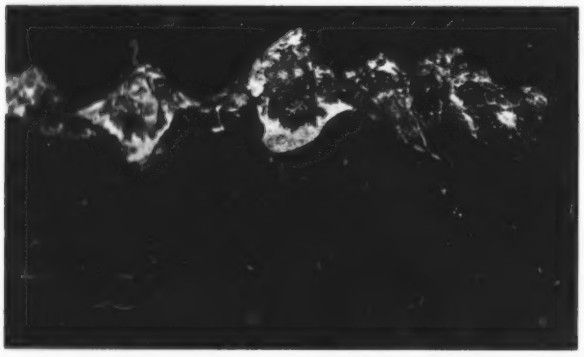
_____

A. Keith, U.S. Geological Survey

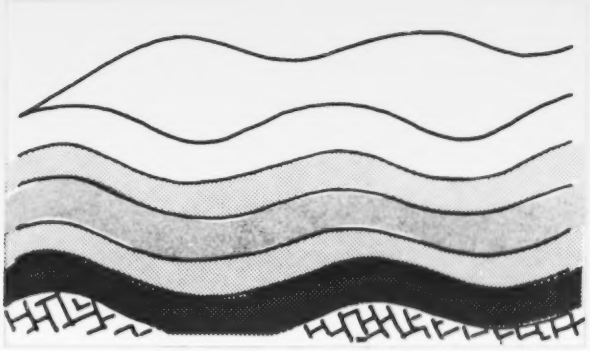


The Appalachian Mountains, eastern North America

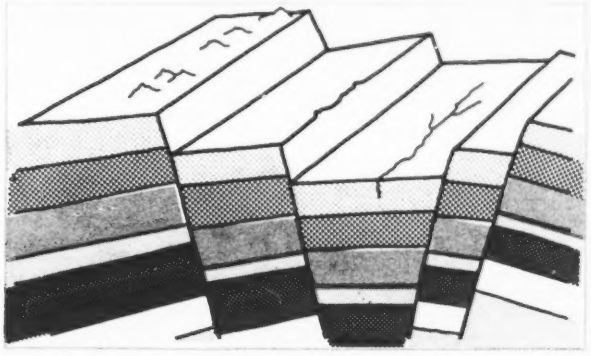
Grand Teton National Park



The Grand Teton Mountains, Grand Teton National Park, Wyoming



Folded mountains



Block mountains

Pushing Up Mountains

You learned that Earth's plates can move away from each other. But Earth's plates can also move *toward* each other. They can *collide* with each other and slowly push up new landforms. What are the landforms?

Right! The landforms are mountains.

(Remember that plates are huge blocks of Earth's crust and they ride on the mantle. Part of the mantle is made up of *magma* — melted rock.)

Sometimes, when plates collide, this happens: The two plates slowly push against each other. That causes the rocks on their edges to become wrinkled and folded. Then those rocks get pushed up. They become mountains.

You can see the folds and wrinkles on those mountains when you look at them from an airplane. The Appalachian Mountains were formed this way.

Another thing that can happen is this: When two plates collide, one slides under the other. The plate on top gets slowly pushed up. The faults on the crust break apart and large blocks of rocks are formed. Those blocks get slowly pushed up. They form mountains.

You can see those blocks when you look at those mountains from far away. The Grand Teton Mountains were formed in this way.

Look at the photographs at the top of this page. Which one shows mountains that were formed by the crust folding up? Which one shows mountains that were formed by one block being pushed up?

Make Two Mountains

Make models of the two kinds of mountains. You will need two balls of modeling clay (or baker's clay) and two pieces of cardboard. Knead the clay until it is soft and stretches.

Follow the directions on this page. Then make labels for your two models. Write *block mountain* on one, and *folded mountain* on the other. Let the models dry. Then paint them to look like real mountains.

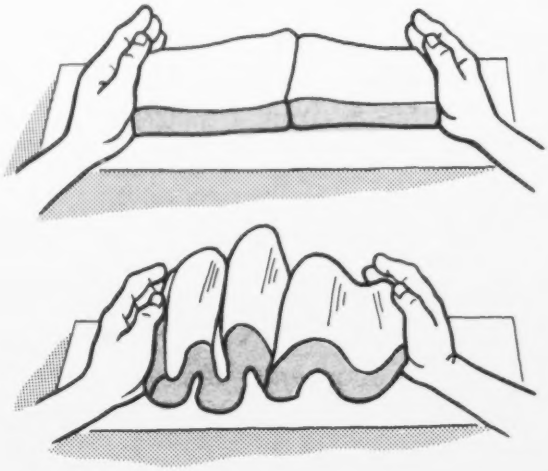
Folded Mountain

1

Divide one ball of clay in half. Flatten the two pieces so they are about ½ inch thick. Those pieces are like the plates of Earth's crust. Place the two pieces next to each other on a cardboard.

2

Push the two pieces together very slowly. The clay should wrinkle and fold. As you push, the clay should rise up to form a folded mountain.



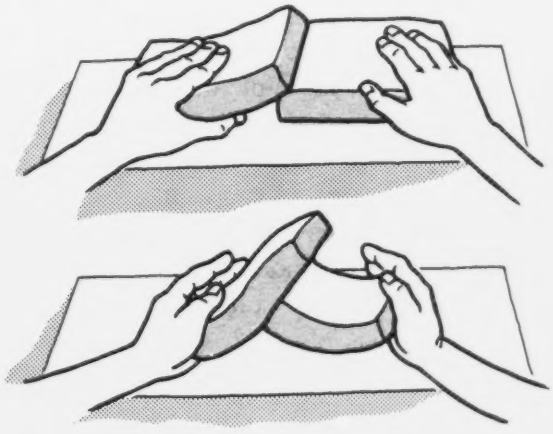
Block Mountain

1

Divide the other ball of clay in half. Flatten the two pieces so they are about ½ inch thick. Place the two pieces next to each other on the other cardboard. Put the edge of one piece over the other.

2

Push the two pieces together so one slides under the other. The top piece should rise up to form a block mountain.



Volcanoes

You know that there is very hot, melted rock deep inside Earth. When melted rock is inside Earth, we call it magma. Sometimes magma flows up to the surface of Earth. It **erupts** through openings in the crust called **vents**. Then we call it *lava*.

Lava can form a mountain. We call that kind of mountain a volcano. How do you think lava can form a mountain?

Right! Lava piles up each time it erupts. It piles up higher and higher to build up a mountain. Mount St. Helens is a volcano in Washington that was built that way.

It can take thousands of years to build a volcano. For example, it took 40,000 years to build up Mount St. Helens. But sometimes volcanoes can rise up in only a few years. Paricutin Volcano in Mexico is an example.

In 1943, lava suddenly erupted in the middle of a flat cornfield close to a village. That was the start of Paricutin Volcano. By 1952, the volcano was over 1,300 feet high. And the village was gone — completely covered by lava.

Volcanoes can also form islands. One of our states is made up of islands that were formed by volcanoes. In fact, those islands are the tops of volcanoes. What is the name of those islands?

Right! The Hawaiian Islands are the tops of volcanoes. Those volcanoes built up from the ocean floor.

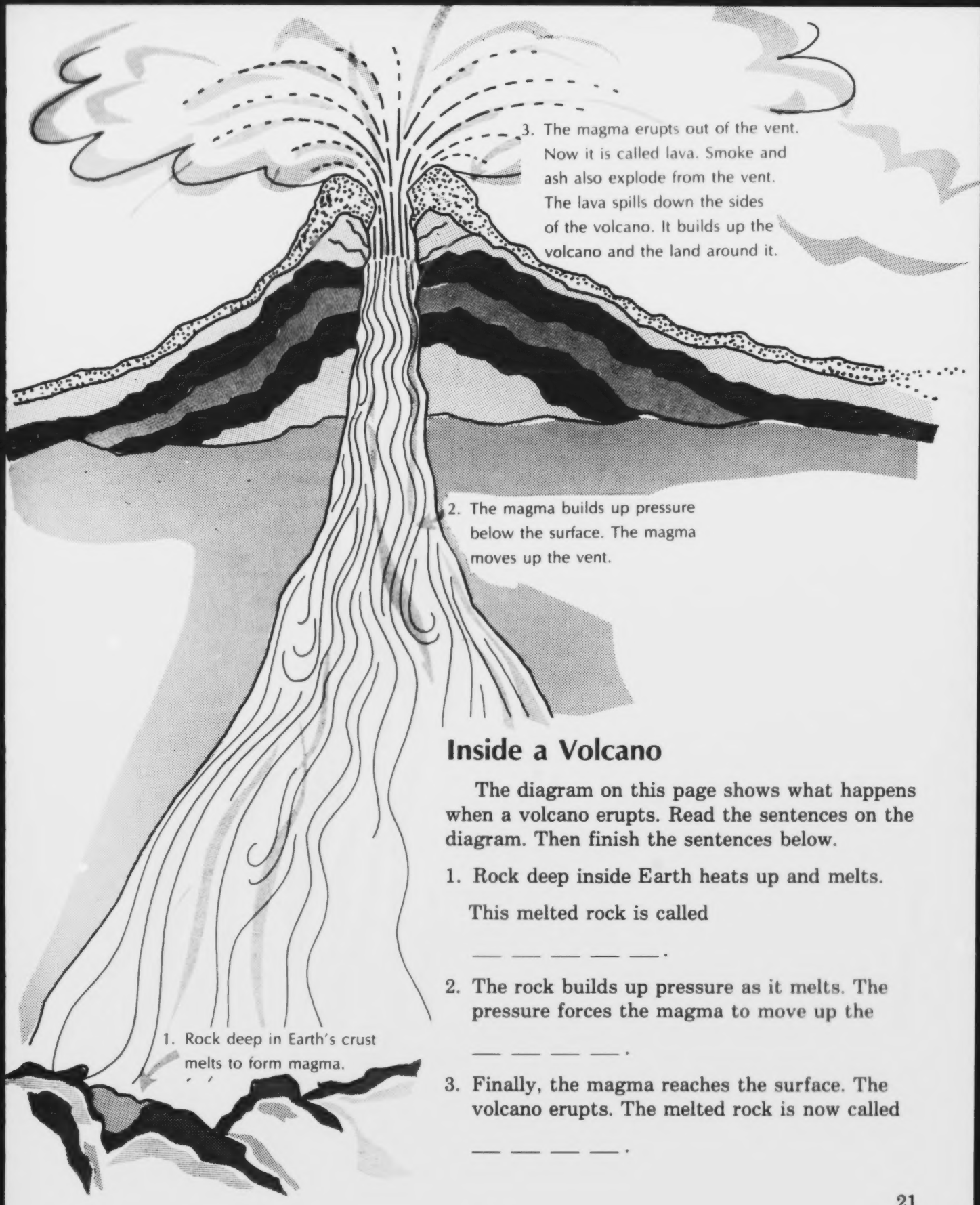
Austin Post, U.S. Geological Survey

Mount St. Helens erupted in 1980.

W.F. Fosheg, U.S. Geological Survey

K. Segerstrom, U.S. Geological Survey

Paricutin Volcano grew out of a flat cornfield.


3. The magma erupts out of the vent. Now it is called lava. Smoke and ash also explode from the vent. The lava spills down the sides of the volcano. It builds up the volcano and the land around it.
2. The magma builds up pressure below the surface. The magma moves up the vent.
1. Rock deep in Earth's crust melts to form magma.

Inside a Volcano

The diagram on this page shows what happens when a volcano erupts. Read the sentences on the diagram. Then finish the sentences below.

1. **Rock deep inside Earth heats up and melts.**

   This melted rock is called

   — — — — —.

2. **The rock builds up pressure as it melts. The pressure forces the magma to move up the**

   — — — —.

3. **Finally, the magma reaches the surface. The volcano erupts. The melted rock is now called**

   — — — —.

Earth Watch

Are there any mountains in your state or in a nearby state? Find out where the closest mountain is.

What is the name of the mountain?

_____

What kind of mountain is it: folded, block, volcano?

_____

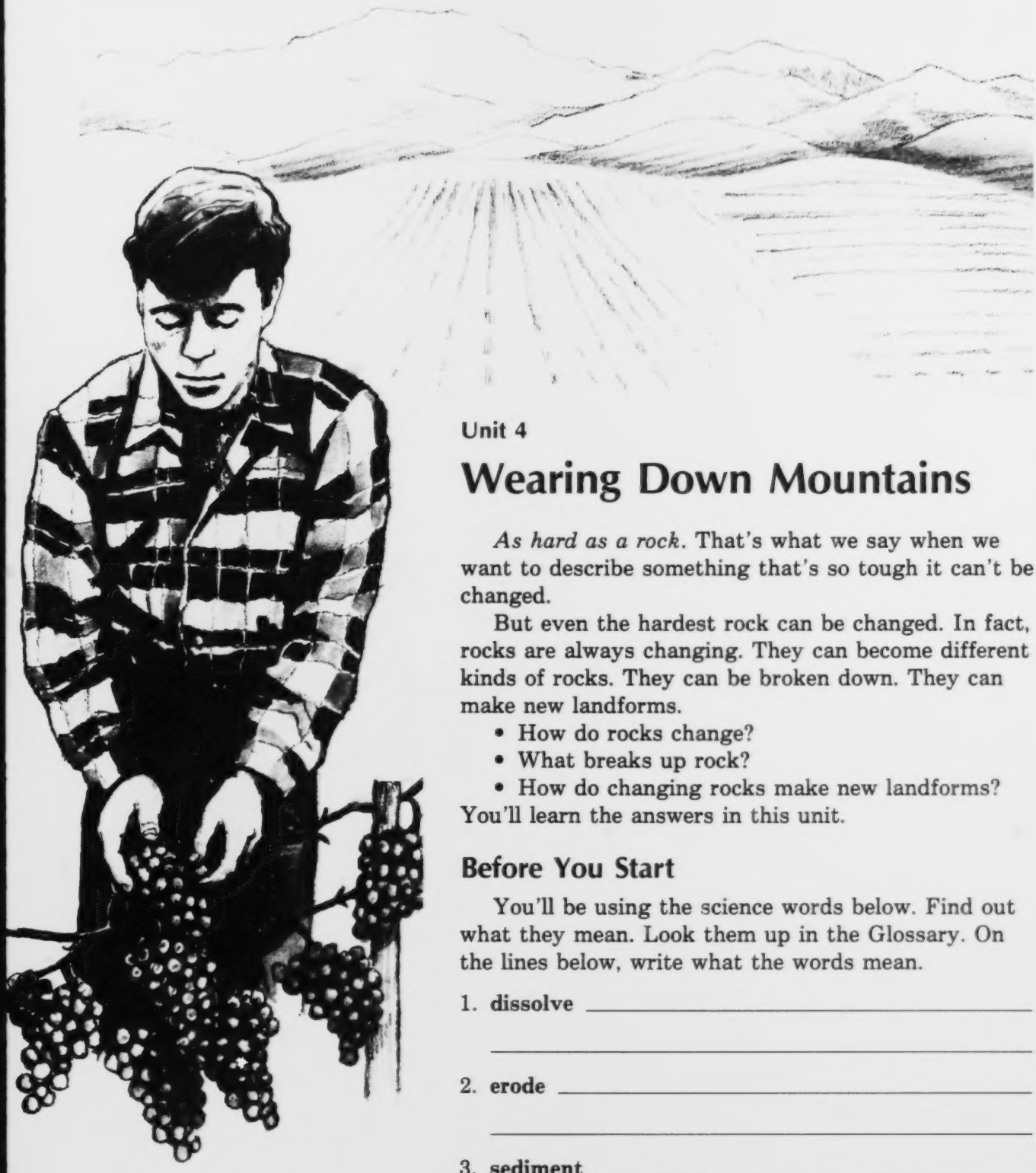
Check Yourself

Finish these sentences. Put an X in front of each right answer.

1. Rock on the crust forms two kinds of mountains when
   - _____ a. plates of Earth's crust collide.
   - _____ b. plates move from each other.
   - _____ c. plates don't change.
2. Folded mountains are formed
   - _____ a. when a volcano erupts.
   - _____ b. during an earthquake.
   - _____ c. when plates collide and push up rock.
3. Block mountains are made
   - _____ a. from superhot lava.
   - _____ b. when plates push against each other and fold up.
   - _____ c. when one plate slides under another.
4. Volcanoes are mountains that build up
   - _____ a. when rocks break apart.
   - _____ b. when melted rock flows from deep inside Earth to the surface.
   - _____ c. when mountains become plateaus.

Check These Out

1. Mount St. Helens is just one of the volcanoes in the United States. Find out what other volcanoes are in the U.S. When did they last erupt? Which one may erupt next?
2. Which is the highest mountain in the U.S.? In the world? Find out. Look in an encyclopedia under *mountains*.
3. Watch the newspapers for articles about volcanoes. Add these articles to your notebook. Mark their locations on your map.
4. Find out more about the Appalachian Mountains and the people who live there.
5. Make a poster that shows the three main kinds of mountains.
6. How do scientists tell when a volcano might erupt? Find out.



Unit 4

Wearing Down Mountains

As hard as a rock. That's what we say when we want to describe something that's so tough it can't be changed.

But even the hardest rock can be changed. In fact, rocks are always changing. They can become different kinds of rocks. They can be broken down. They can make new landforms.

- How do rocks change?
- What breaks up rock?
- How do changing rocks make new landforms?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **dissolve** _____

_____

2. **erode** _____

_____

3. **sediment** _____

_____

Changing Rocks

You know that Earth's crust is made of solid rock. That rock is always changing.

Rock can be changed by the heat deep inside Earth. The heat melts the rocks inside the crust. The rocks become magma. The magma then moves up toward the surface. It cools and hardens into another kind of rock. We call rock that forms that way **igneous rock.**

Rocks deep inside Earth can also change into another kind of rock. The tremendous heat and pressure inside Earth causes them to change. They make the rocks very hard. We call rock that changes that way **metamorphic rock.** A diamond is a metamorphic rock.

Rocks on top of Earth's surface can also change into another kind of rock. Here's how: The rocks are broken up into tiny bits — *sediments.* The sediments get into oceans and lakes. They form layers on the bottoms of the oceans and lakes. The layers harden into rock. That new rock is called **sedimentary rock.**

Look at the photographs of the different rocks on this page.

1. What kind of rocks are *granite* and *basalt*?

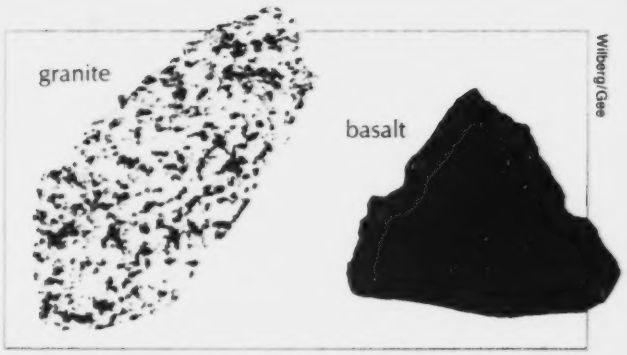
   _____

2. What kind of rocks are *sandstone* and *shale*?

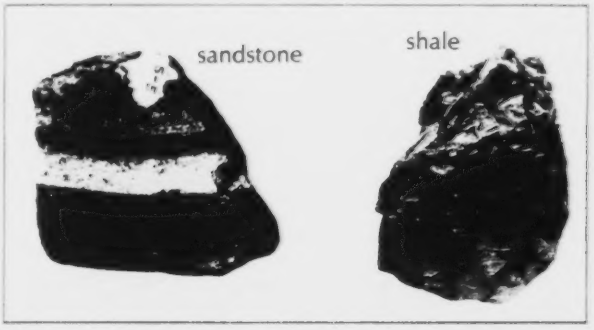
   _____

3. What kind of rocks are *gneiss* and *slate*?

   _____



These rocks were formed from hot melted magma or lava.



These rocks were formed from layers of sediment.

all other photos by U.S. Geological Survey

These rocks were formed by heat and pressure deep inside Earth.

Answers

1. igneous 2. sedimentary
3. metamorphic

Breaking Them Up

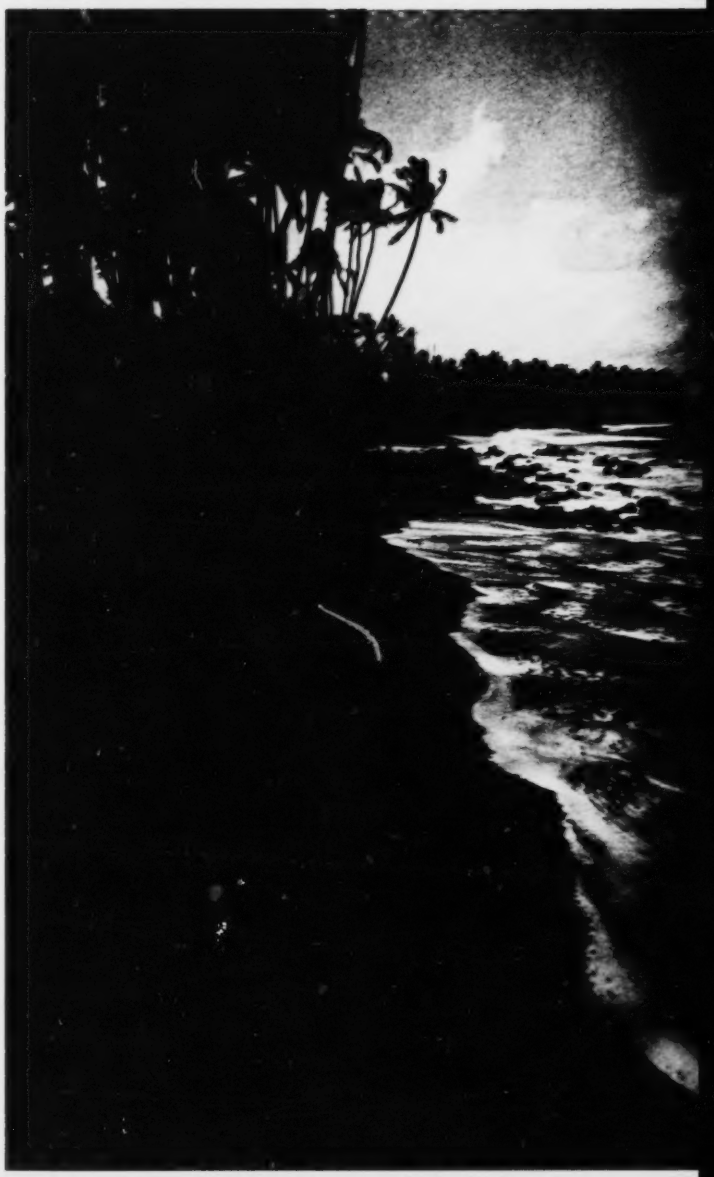
Rocks are usually hard and strong when they are first formed. But as time passes, things happen that can weaken the rocks and break them up. What do you think could happen to break up rocks?

Trees and plants can grow in rocks. They start growing in small cracks in the rocks. They send out small roots. What happens as a plant grows bigger?

Right! As a plant grows bigger, its roots grow bigger. The roots force the crack to open wider. If the roots grow big enough, they can split the rock apart.

Weather can also help break up rocks. Heavy rain can make holes on certain kinds of rock. It can also loosen small rocks from mountains and hills. And it can carry away those loose rocks.

Some rocks can be worn down when certain chemicals mix with water. When that happens, the chemicals and water form acids. Those acids are strong enough to *dissolve* rock. For example, sometimes rain mixes with certain chemicals that are in smoke. They form an acid. That acid comes down with the rain. It dissolves rocks such as limestone and marble. It makes large holes and cracks in those rocks.



J. D. Griggs

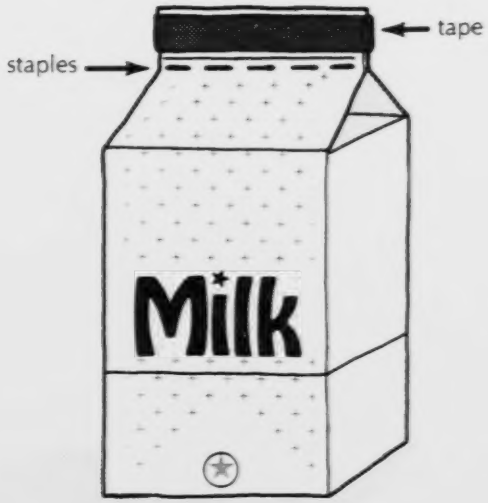
This beach is called the Kalapana Black Sand Beach. The sand is made up of broken bits of lava rock.

Rock Breaker

Water can get into cracks in rocks. When the temperature drops below 32°F (or 0°C), that water freezes into ice. Ice can break up rocks. Find out why. You will need: a small empty milk carton, a stapler, water, tape, and a freezer.

1

First, fill the milk carton *all the way to the top* with water. Then, staple across the top of the carton about five times. The top should be tightly shut. Tape over the top.



Before freezing

2

Place the carton in the freezer. Leave it there until the water turns to ice — about 24 hours. What happens to the carton? Draw a picture of it.

After freezing

What Happens?

1. What happens to water when it freezes?

   _____

2. Water **expands** (takes up more room) when it freezes. What can happen when water freezes in a crack in a rock?

   _____

   _____

Another Rock Breaker

What happens when acid rain falls on rocks such as limestone or marble? Find out! You will need an acid such as vinegar. You will also need: two pieces of limestone, two small glass jars, a felt pen, and water.

1

Write *water* on one jar. Pour 1 cup of plain water into that jar.

Write *acid* on the other jar. Pour 1 cup of vinegar into that jar.

2

Put a piece of limestone in each jar. Put the jars in a safe place. The next day, look at the limestones in both jars.

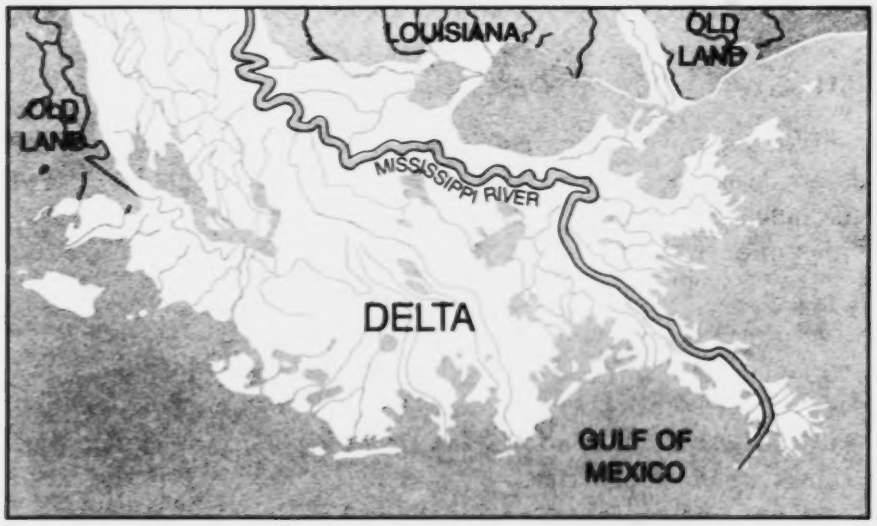
What Happens?

1. What happens to the limestone in the plain water?

   _____

2. What happens to the limestone in the acid?

   _____



This map shows the Mississippi Delta. The Mississippi flows into the sea here. The fan-shaped landform is the delta.

Take Them Away

Rocks get broken into small pieces. What do you think happens to those pieces?

Rain carries away those pieces.

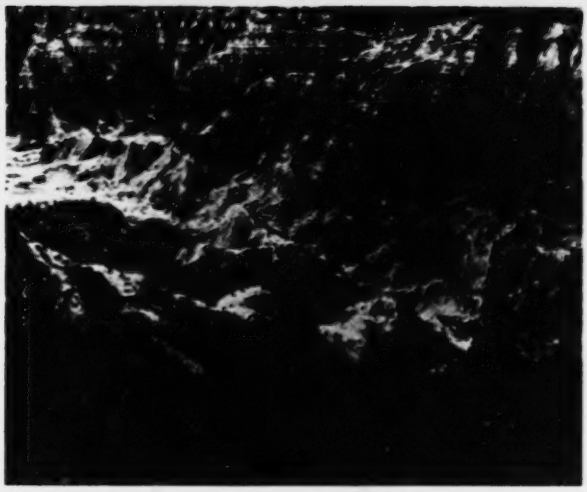
Rainwater can wash sediments down hills and mountains into streams. Small streams then carry those sediments into large streams. The large streams carry the sediments into rivers. The rivers then carry the sediments into a lake or ocean.

Water must move in order to carry sediments. The faster the water moves, the bigger the sediments it carries. What do you think happens to the sediments when the water slows down?

Right! The sediments are **deposited**. They drop to the bottom. The biggest pieces drop first. As the water gets slower, the smaller pieces drop. When the water stops completely, all the pieces slowly drop out.

Sediments that are deposited this way can build up new landforms. For example, sediments can build islands in the middle of rivers. They can form *deltas* where a river runs into an ocean. A delta is a landform that is shaped like a fan. Deltas can spread for many miles.

Look at the map. It shows where the Mississippi River runs into the Gulf of Mexico. Look for the delta. Circle it on the map.



N.H. Darton, U.S. Geological Survey

Part of the Great Plains, South Dakota

1. _____

G.S. Rogers, U.S. Geological Survey

Garden of the Gods, Colorado

2. _____

Yosemite National Park

Yosemite Valley, Yosemite National Park, California

3. _____

Erosion

Suppose a landform is very flat. Then water and wind begin to break up the rocks on that land. Rain carries away sediments. What happens to that landform?

_____

_____

Right! The landform *erodes*. It wears down.

The photograph on top of this page shows one part of the Great Plains. The land used to be very flat. Now it has many *gullies*. Gullies are big cuts in the land that are made by running water. The water breaks up rocks. It washes away the rocks and erodes the land.

Erosion can wear down a landform. The Great Plains are an example. They are being eroded by running water.

Wind can also cause erosion. Strong winds can pick up pieces of sand and blow them against rocks. The sand rubs off bits of the rocks the way sandpaper rubs off bits of wood.

There is another way landforms can be eroded. Landforms can be eroded by **glaciers**. What are glaciers made of?

_____

Right! Glaciers are made of ice.

Glaciers have many huge rocks frozen to them. As the glaciers move, those rocks scrape the land. They dig out land and form huge valleys.

Now look at the pictures. They show landforms that are eroded. What caused the erosion? Write *ice*, *wind*, or *water* under each picture. Then check your answers. (The right answers are upside down.)

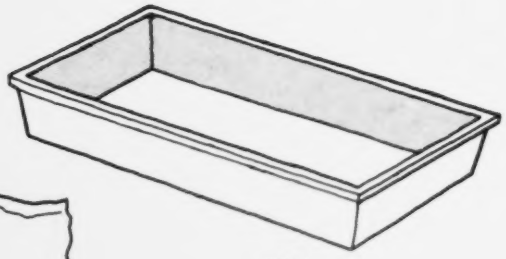
Answers

1. water 2. wind 3. ice

Make a Stream Table

A stream table shows how water causes erosion. You make a model of a landform. Then you spray water on it. The running water makes gullies. It also makes deltas. To make a stream table you need:

- a large, flat, plastic or foil pan
- scissors or knife
- shower hose
- waterproof tape
- two buckets
- sand
- water faucet



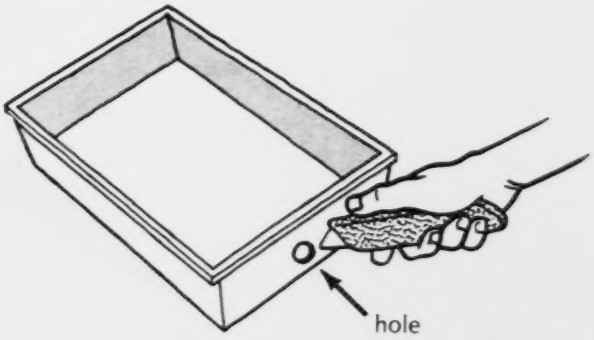
pan

shower hose

sand

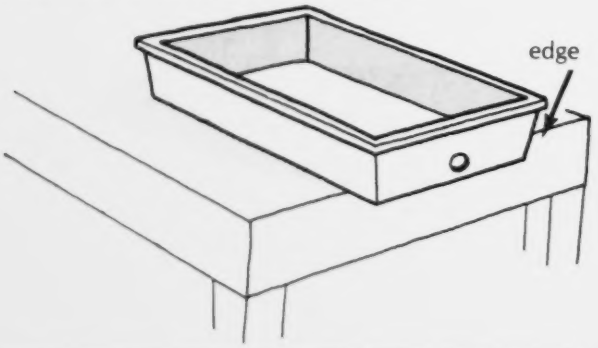
1

Cut a hole in one end of the pan. Cut it close to the bottom.



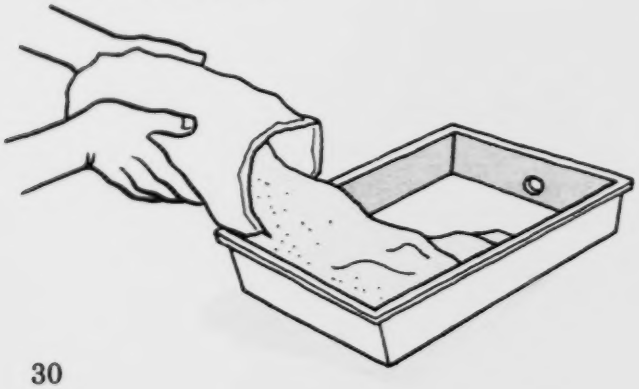
2

Place the pan on a counter or table near the water faucet. Put the end with the hole a little over the edge.



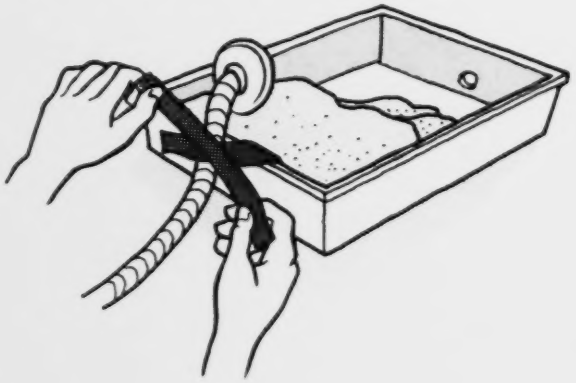
3

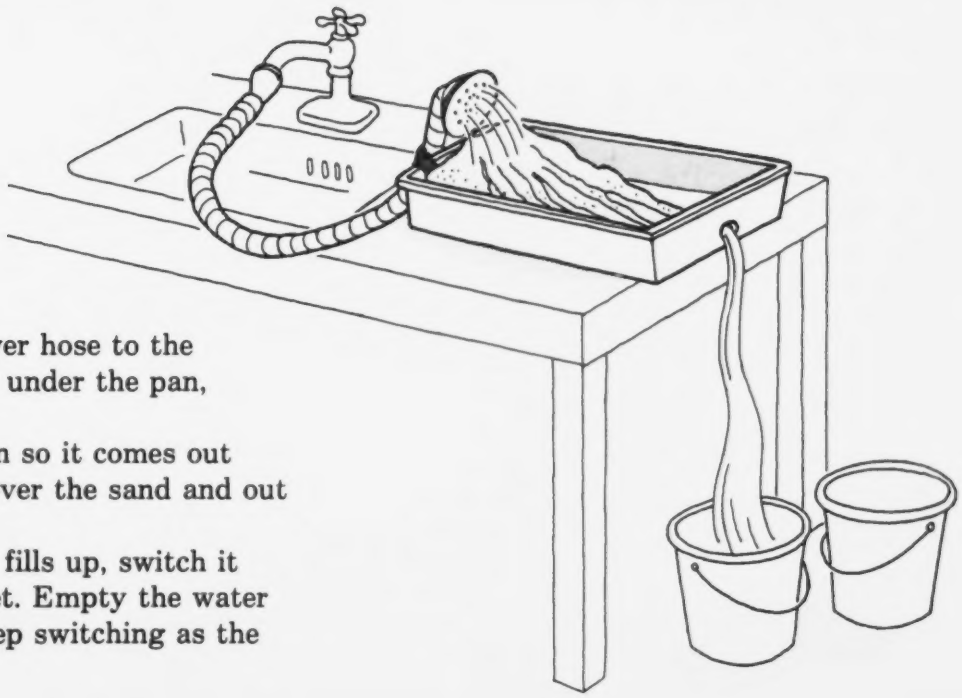
Pour sand into the pan at the end that doesn't have the hole. Make a little hill with the sand.



4

Tape the shower end of the hose to the pan, next to the sand.





5

Connect the shower hose to the faucet. Put a bucket under the pan, where the hole is.

Turn the water on so it comes out slowly. It will flow over the sand and out the hole.

When the bucket fills up, switch it with the other bucket. Empty the water from the bucket. Keep switching as the buckets fill up.

6

Watch what the water does. Does it form streams? Does it make little lakes? Watch how it makes gullies in the hill and carries away the sand.

After 20 minutes, turn off the water. What happens to the sand? Look for landforms such as plateaus, plains, deltas, and islands. Draw what the sand now looks like.

Earth Watch

Locate a big river on a highway map of your state. Trace over the river with a light-colored marking pen. Use the map to answer the questions below.

1. What is the name of the river?

_____

2. Where does it start from?

_____

3. What does it flow into?

_____

Check Yourself

Answer the questions. Then check your answers. Look at the page after each question.

1. What are some ways that rocks change? (page 24)

_____

_____

_____

_____

2. What causes rocks to break up? (page 25)

_____

_____

_____

_____

3. What happens to rock that is broken up? (page 28)

_____

_____

_____

Check These Out

1. Gems are found in many different kinds of rocks. Look up these gems. Find out how they were formed and where they are found.
   - Garnet
   - Tourmaline
   - Ruby
   - Amethyst
   - Diamond
2. The Grand Canyon was eroded by a river. What river is it? How long did it take to erode the canyon? Find out.
3. Fill a peanut butter jar halfway with dirt. Then fill it the rest of the way with water. Put the lid on it. Shake the jar hard. Let the jar set overnight. What does the dirt look like now? Draw a picture of it.
4. Add a glacier (ice cube) to your stream table. What happens as it melts?
5. Some great floods have changed the lives of many people. Find out more about these floods:
   - Johnstown, Pennsylvania (1889)
   - Rapid City, South Dakota (1972)
   - Big Thompson Canyon, Colorado (1976)

Unit 5

Climate

Think about a cold winter day. People wear heavy coats. Snow covers the ground. An icy wind blows across the land.

Now think about a hot summer day. The air seems wet and heavy. People wear light clothing. The sun seems to burn the land.

Cold winters and hot summers are certain kinds of *climate*. Earth has many different kinds of climate. A climate can be cold, warm, or hot. It can also be dry or wet. But no matter what a climate is like, it causes changes on Earth.

- How do climates change Earth?
- How do scientists study those changes?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **ice age** _____

_____

2. **moraine** _____

_____

Susan Kaschner Jagoda

Death Valley National Monument is in southern California.

Hawaii Visitors Bureau

Hawaii is one of the Hawaiian Islands.

Cool or Warm, Wet or Dry

Death Valley is a desert. What kind of climate do you think Death Valley has?

_____

Hawaii is an island in the middle of the Pacific Ocean. What kind of climate do you think Hawaii has?

_____

Did you say Death Valley is *hot* and *dry*? And Hawaii is *warm* and *wet*?

Hot, *warm*, *dry*, *wet*. Those are the kinds of words we use to describe the climate of a place. Climate is the kind of weather a place has year after year.

The climate in one place can be very different from the climates in other places. For example, Seattle, Washington, is usually wet and cool. The climate of Phoenix, Arizona, is usually warm and dry.

The climate a place has can help change the land. How do you think the land can change where the climate is very rainy and wet?

_____

_____

Right! Where there is lots of rain, running water can erode the hills. Plants grow faster and their roots help break down rocks.

Sometimes a landform causes a certain climate to happen. For example, mountains sometimes cause rain to fall. The rain forms when wind pushes wet air up the side of the mountain. That rain usually falls just on one side of the mountain.

Which side of the mountain do you think erodes faster?

_____

What's Your Climate?

Some places don't have the same climate all year long. For example, they may have summers that are warm and **humid** (warm/humid). They may also have winters that are cold and wet (cold/wet). The map shows the main regions of the United States. It also shows the summer climate for those regions. Each color stands for a certain climate.

Look at the map. Find the cities listed in the next column. Circle them on the map. Then write the kind of climate each city has during the summer. (The first is done.)

1. San Francisco, California
   cool/dry
2. Salt Lake City, Utah
   _____
3. Detroit, Michigan
   _____
4. Miami, Florida
   _____

Find the region you live in on the map. Put an **X** where your state is. What kind of summer climate does your community have?

_____

Climates of the Past

A hundred million years ago, Earth was warm and humid. Tropical plants grew in huge forests. Then, about 70 million years ago, the climate changed. Earth started cooling and the tropical plants died.

We know that happened because of certain evidence that scientists find. The evidence gives us clues about what climates were like long ago.

To find evidence, scientists drill deep holes in the ocean bottom. They take out **core samples**. A core sample shows the layers of sediment that make up the ocean bottom. Scientists study the fossils in a layer to see how hot or cold a climate was. They measure how thick the layer is to see how long that climate lasted.

Scientists study the bottoms of lakes. They look for layers of sediment that were left when the glaciers melted. If they find a very thick layer of sediment, that tells them the glaciers were melting fast. What do you think the climate was like to cause that?

Right! The climate was very warm.

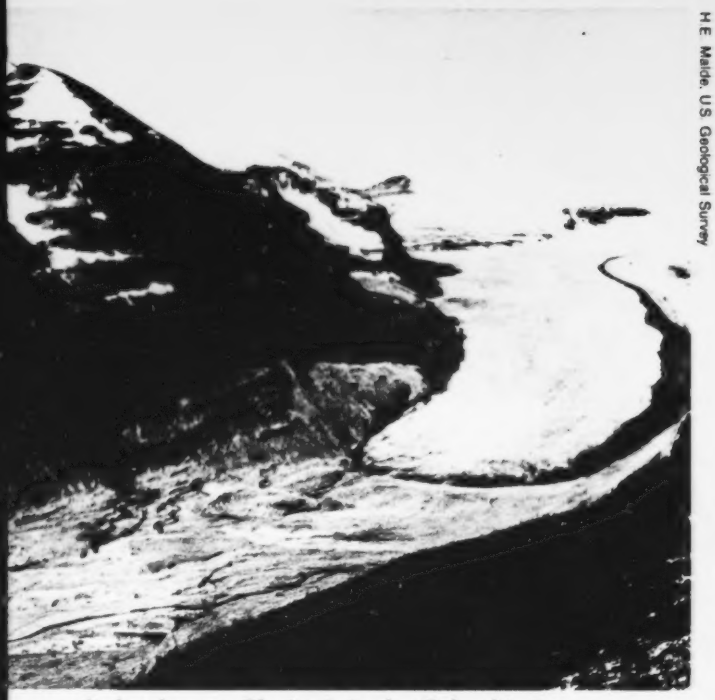
Scientists also look for evidence in trees. Trees grow a new layer of wood every year. We call those layers *growth rings*. You can see the rings when the tree trunk is cut across.

By studying growth rings, scientists can tell what the climates were like many years ago. When the climate is wet and warm, a tree grows fast and its ring is wide. When the climate is very dry, a tree grows slowly, and its ring is thin.

The photograph shows the growth rings of a tree. Which rings show that the climate was very wet? Get a colored pencil. Color those rings.

U.S. Geological Survey

The arrows mark every tenth year of the tree's life. Notice that the arrows are farther apart during the wet years than during the dry years. What does that tell you about how fast or slow the tree grew?



H.E. Malde, U.S. Geological Survey

Saskatchewan Glacier is in the Columbia Ice Field, Alberta, Canada.

Yosemite National Park

Half Dome in Yosemite National Park was formed by glaciers.

Ice Ages

Earth has had several *ice ages*. During the ice ages the climate was very cold for millions of years. Sheets of ice, some a mile thick, covered large parts of many continents. Scientists believe the last ice age began about two or three million years ago.

During the ice ages, glaciers covered most of North America. They started as small ice sheets in northern Canada. As the ice sheets grew, they started to move.

The glaciers picked up huge rocks. They carried the rocks for hundreds of miles. They scraped and dug up land. They carved huge valleys as deep as Yosemite Valley in California. They hollowed out lakes as large as the Great Lakes in the Midwest. They pushed rocks and soil ahead of them. They ground up rocks into a fine dust.

Then the climate of Earth changed. It got warmer. The glaciers slowly melted. The rocks and dirt in the glaciers were deposited. Streams of water from the glaciers carried sediments far away. Other sediments were dumped at the glaciers' edge. They formed large hills called *moraines*. You can find moraines in places like Michigan and other states in the Midwest.

Some scientists think that the last ice age isn't over yet. They think the glaciers might come back. What do you think would happen if the glaciers did come back?

_____

_____

Earth Watch

1. What is the summer weather like where you live?

_____

2. What is the winter weather like where you live?

_____

3. Check with your parents, grandparents, and older friends to find out about any strange weather that might have happened where you live. For instance, were there any very cold and snowy winters? Write their answers here.

_____

_____

_____

Check Yourself

Write your answers. Then check your facts. Look at the page after each sentence.

Give one example of:

1. A climate. (page 35)

_____

_____

2. How a very wet climate changes the land. (page 34)

_____

_____

3. How glaciers changed the land. (page 37)

_____

_____

4. How scientists find out about past climates. (page 36)

_____

_____

Check These Out

1. Find out what the chinook, Santa Ana, and sirocco winds are. Where do they happen?
2. *Climatologists* are scientists who study climate. Find out what they do. Find out about other jobs that have to do with climate.
3. What parts of our country did the glaciers cover during the last ice age? Did they cover the place where you live? Draw a map that shows what parts were covered by glaciers.
4. Scientists have several ideas about why the dinosaurs disappeared. Some think they died out because the climate changed. Find out what the climate was like when the dinosaurs lived. What do scientists say happened to change the climate?

Unit 6

People Change the Earth

You've learned some ways that Earth changes. The crust moves and changes the shape of a land. Volcanoes erupt and build up mountains. Wind, rain, and ice break down rocks and make new landforms. All those things happen because of changes in Earth's crust and the atmosphere.

But Earth is also changing because of *people*. Before people came, Earth's changes sometimes took thousands of years to happen. The changes that people make can happen very quickly.

- What do people do that cause changes?
- What are the changes people are making?
- What are people doing about those changes?

You'll learn the answers in this unit.

Before You Start

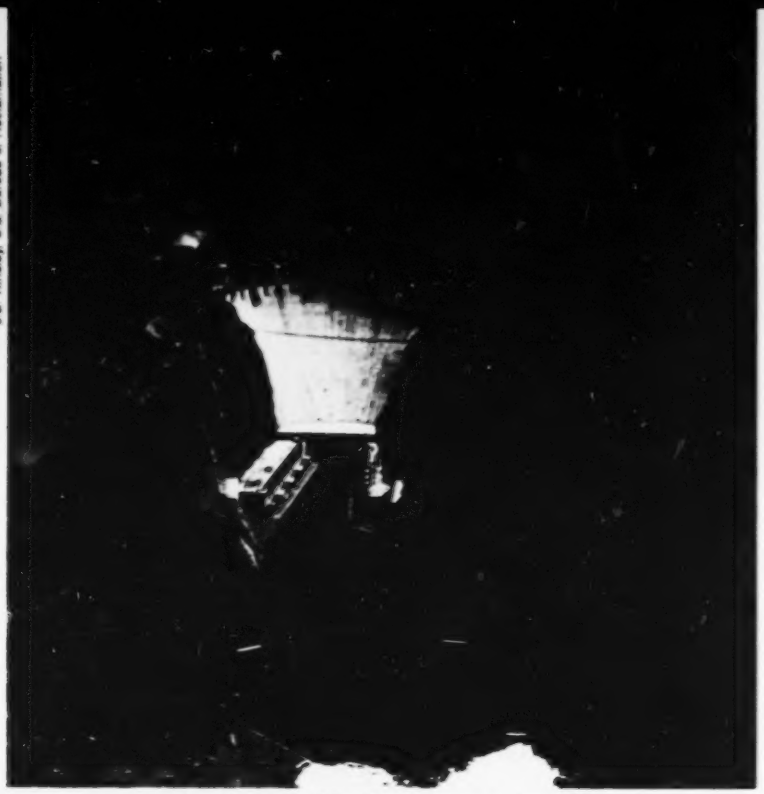
You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **fossil fuels** _____

_____

2. **greenhouse effect** _____

_____



J.E. Kinsley, U.S. Bureau of Reclamation

People built this dam across a river. The dam holds back some of the river water to make a lake.

Builders and Makers

The first human beings appeared on Earth about two million years ago. In order to survive, they needed water, food, shelter, clothing, and tools. They got those things from Earth.

Early people broke up rocks to make tools. They learned to make things from wood and metals. They learned to dig wells for water and to plant crops. As they did those things, they began to change Earth.

Today millions more people live on Earth. We need and want more than early people did. We are changing Earth faster than those early people ever could.

We fill in rivers and swamps to make new land. We blow up landforms to make roads and bridges. We make lakes to hold water for farming and drinking. We dig deep into the ground for fuel such as oil, coal, and gas.

We also cover large parts of the land with cities and towns. Here's what happens when we build a new community: First we dig up landforms. Then we cover the ground with concrete. We build buildings. We build streets and parking lots. To make those things, we use rocks, minerals, and fuels that we dig from the ground. We use wood from trees we cut down. What changes to Earth do you think all that causes?

The Greenhouse Effect

When fossil fuels burn, smoke, gases, and dust form. Where do they go?

_____

Right! The smoke, gases, and dust all go into Earth's atmosphere.

Scientists say the atmosphere keeps Earth warm. They call it the *greenhouse effect*. (A greenhouse is a glass building that plants grow in.)

Suppose it's a freezing cold day. You get into a car that's been parked in the sun. All the windows are closed tight. Inside the car, it's warm! You are feeling the greenhouse effect.

Light from the sun passes through the glass windows. The air inside the car becomes warm. The closed windows keep the warm air from leaving. So, the car stays warm.

Earth's atmosphere acts something like the glass windows. Sunlight passes through the atmosphere and heats the land. At night, the heat leaves the land and goes into the atmosphere. Some of that heat then goes into space. But enough heat stays in the atmosphere to keep Earth warm.

Some scientists think that the gases, smoke, and dust in the atmosphere are causing too much heat to stay in. They think Earth is getting warmer. How might Earth change if that's so?

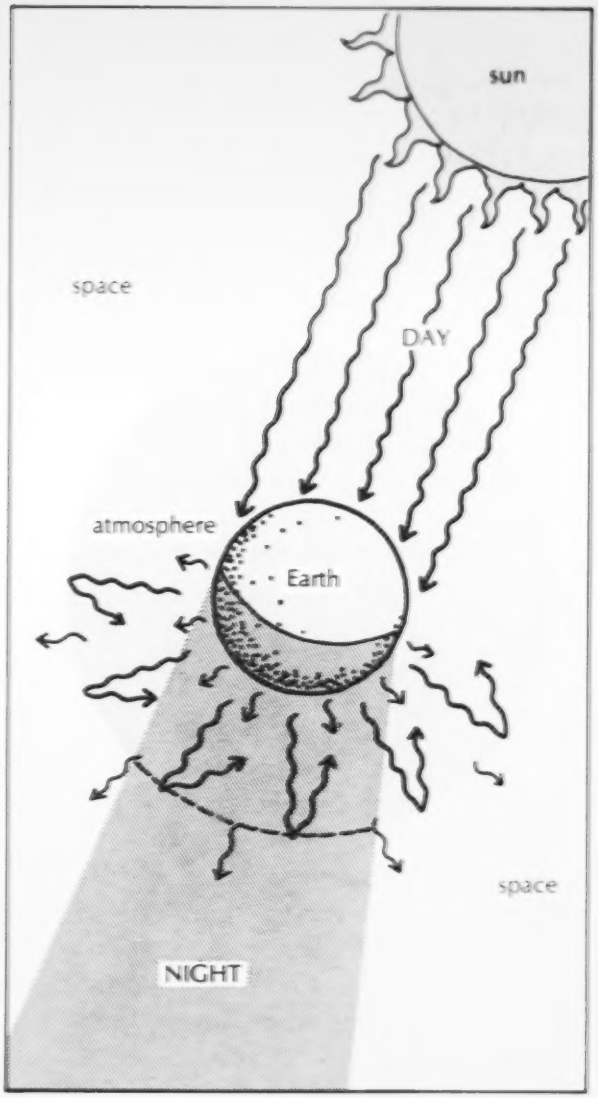
_____

_____

Other scientists think that the gases, smoke, and dust are blocking out sunlight. They think Earth is getting colder. How might Earth change if that's so?

_____

_____



Day: Heat from the sun warms Earth.

Night: Heat leaves Earth and goes into the atmosphere. What would happen if Earth didn't have an atmosphere?

_____

_____

Looking at the Future

People have been changing Earth for over a million years. At first, people didn't think about the future. For example, they would cut down all the trees in an area for firewood. They didn't know what that would do to the land.

When all the trees in a large area are cut down, the land erodes quickly. The climate can get dry and windy. After many years, the land can become so rocky that plants won't grow.

People have also burned lots of coal and oil for a long time. They didn't realize the changes they were causing to the land and air. What changes did they cause?

_____

_____

To get coal and oil, people dug mines and wells. That caused erosion to the land. When they burned those fuels, gas and smoke polluted the atmosphere. Chemicals polluted the water and land.

Today people try to figure out what might happen in the future. They study the land before they build or dig on it. They try not to ruin the land.

People also know that landforms change. They know what can happen to lands that are near faults and volcanoes, or low lands that are next to rivers. So, before people build on a land, they find out how it might change. Why is that a good idea?

_____

_____

_____

R.E. Wallace, U.S. Geological Survey

This photograph was taken from an airplane. It shows houses that are built next to a fault. Do you think people planned for the future? Why or why not?

_____

_____

_____

Earth Watch

People are probably changing the land near where you live. Think of a place near your home where people are changing the land. It might be a highway that's being built, or a building that's going up.

1. What is the name of the place?

_____

2. What is being built there?

_____

3. What changes are happening to the land?

_____

_____

_____

Check Yourself

Answer the questions. Then check your answers. Look at the page after each question.

1. How are people changing the land? (page 40)

_____

_____

_____

2. How are people changing the atmosphere? (page 41)

_____

_____

_____

3. How can we plan for the future? (page 42)

_____

_____

_____

Check These Out

1. Suppose you are stranded on a desert island. What do you need to survive? How will you get those things? Write a story to describe how you survive.
2. Find out how fossil fuels are formed. Where do we find large supplies of those fuels in the world today?
3. Find out more about how greenhouses work. How warm can they get? What kinds of plants grow best in greenhouses?
4. The Environmental Protection Agency (EPA) is a government office. It looks after the country's *natural resources*. Find out about the EPA.
5. Find newspaper articles that warn about changes in Earth. Cut out those articles. Make a poster.

Paste a photograph here
of the land you live on.

Unit 7

The Land You Live On

You have gathered a lot of information about the place where you live. Look over the Earth Watch pages at the end of each unit. Then answer these questions.

1. What kind of landform do you live on? Describe it.

_____

_____

_____

2. What faults are nearest you?

_____

3. What mountains are nearest you?

_____

4. What rivers are nearest you?

_____

5. What kinds of climate does your area have?

Spring: _____

Summer: _____

Fall: _____

Winter: _____

6. What kinds of changes are people making?

_____

_____

7. What do you think the land will be like one million years from now? Write a story or draw a picture.

8. Why do you think that will happen?

_____

_____

_____

_____

Show What You Learned

What's the Answer?

Put an **X** in front of the right word or words. There may be more than one correct answer to a question.

1. Three main kinds of landforms are
   _____ a. plains, plateaus, mountains.
   _____ b. streams, lakes, oceans.
   _____ c. land, water, air.
2. Earth's crust is
   _____ a. cracked by faults.
   _____ b. in the center of Earth.
   _____ c. moving.
3. Mountains form when
   _____ a. landforms erode.
   _____ b. plates collide.
   _____ c. volcanoes erupt.
4. Rocks can be worn down by
   _____ a. plants.
   _____ b. acids.
   _____ c. wind and running water.
5. Landforms can be changed by
   _____ a. glaciers.
   _____ b. heavy rain.
   _____ c. growth rings.

Why should we be worried about how people change Earth?

_____

_____

_____

_____

What's the Word?

Write the correct word for each meaning.

1. A large piece of land
   C _____
2. Hot melted rock inside Earth
   M _____
3. To wear away land
   E _____
4. The shape of a piece of land
   L _____
5. A huge, moving body of ice
   G _____
6. Bits of rock
   S _____
7. A scientist who studies Earth
   G _____

Congratulations!

You've learned a lot about our changing Earth. You've learned:

- what Earth is made of;
- how mountains and continents are formed;
- how Earth is changing;
- how people can change Earth; and
- many other important facts about the planet you live on.

Glossary

at mo sphere The air that surrounds Earth.

col lide To crash or run into something.

con ti nent A very large piece of land that's mostly surrounded by water.

core The center of Earth.

core sam ple A sample of the Earth from the bottom of a lake or ocean.

crust The rocky outside part of Earth.

de pos it To drop out of water.

dis solve To break down into very small pieces in water.

e rode To wear away.

e rupt To explode and push out of Earth.

ev i dence Clues left by something.

ex pand To take up more space.

fault A deep crack on Earth.

fos sil The remains of a plant or animal that lived a long time ago.

fos sil fuels Fuels that are made from plants or animals that lived millions of years ago; coal, oil, and natural gas.

ge ol o gist A scientist who studies Earth.

gla cier A huge body of ice that moves across the land.

green house ef fect The way the atmosphere traps the sun's heat.

hu mid Having moisture in the air.

ice age A time when much of Earth is covered with ice.

ig ne ous rock Rock that forms from melted rock.

land form The shape of a piece of land.

lay er A thickness of rock or dirt under or on top of another.

mag ma Very hot melted rock that is inside Earth.

man tle The part of Earth that is under the crust.

met a mor phic rock Rock that is changed by heat and pressure deep inside Earth.

mo raine A high hill that forms when a glacier melts.

moun tain A tall, steep kind of land.

plain A low, flat kind of land.

pla teau A kind of land that is not tall or flat.

plates Pieces of the top part of Earth.

pres sure A force or push.

sed i ment Bits of rock.

sed i men ta ry rock Rock that forms from bits of rock.

seis mo graph A machine that records and measures earthquakes.

sur face The top or the outside of something.

val ley A long, low kind of land.

vent An opening in the top of Earth.

Janus Book Publishers
2501 Industrial Parkway West
Hayward, CA 94545
415-887-7070

Changing **Earth**

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ISBN 0-88102-024-9